JULY 1949

Journal

VOL. 41 • NO. 7

AMERICAN WATER WORKS ASSOCIATION

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COMING MEETINGS

September 6–7—New York Section at Otesaga Hotel, Cooperstown, N.Y. Secretary: R. K. Blanchard, Vice-Pres. & Engr., Neptune Meter Co., 50 W. 50th St., New York, N.Y.

8–9—Minnesota Section in Minneapolis, Minn. Secretary: R. M. Finch, 518 Metropolitan Bldg., Minneapolis 1, Minn.

14–16—Pennsylvania Section at Penn-Harris Hotel, Harrisburg, Pa. Secretary: L. S. Morgan, Dist. Engr., State Dept. of Health, Greensburg, Pa.

22–23—Rocky Mountain Section at Acacia Hotel, Colorado Springs, Colo. Secretary: O. J. Ripple, Ripple & Howe, Cons. Engrs., 426 Cooper Bldg., Denver 2, Colo.

September 22–23—West Virginia Section at Oglebay Park, Wheeling, W.Va. Secretary: J. B. Harrington, State Dept. of Health, Charleston 5, W.Va. For reservations write: A. R. Todd, Filtration Plant, Wheeling, W.Va.

25–27—Missouri Section at Connor Hotel, Joplin, Mo. Secretary: Warren A. Kramer, Div. of Health, State Office Bldg., Jefferson City, Mo.

28–30—Michigan Section at Park Place Hotel, Traverse City, Mich. Secretary: Raymond J. Faust, Div. of Water Supply, Bureau of Eng., Michigan Dept. of Health, Lansing 4, Mich.

October 6–7—Iowa Section at Burlington Hotel, Burlington, Iowa. Secretary: H. V. Pedersen, Supt., Water Works, Municipal Bldg., Marshalltown, Iowa.

9–12—Southwest Section at Biltmore Hotel, Oklahoma City, Okla. Secretary: Leslie A. Jackson, Mgr.-Engr. Little Rock Municipal Water Works, Robinson Memorial Auditorium, Little Rock, Ark.

11–13—Wisconsin Section at Hotel Schroeder, Milwaukee, Wis. Secretary: L. A. Smith, Supt., Water Works, City Hall, Madison, Wis.

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Departments

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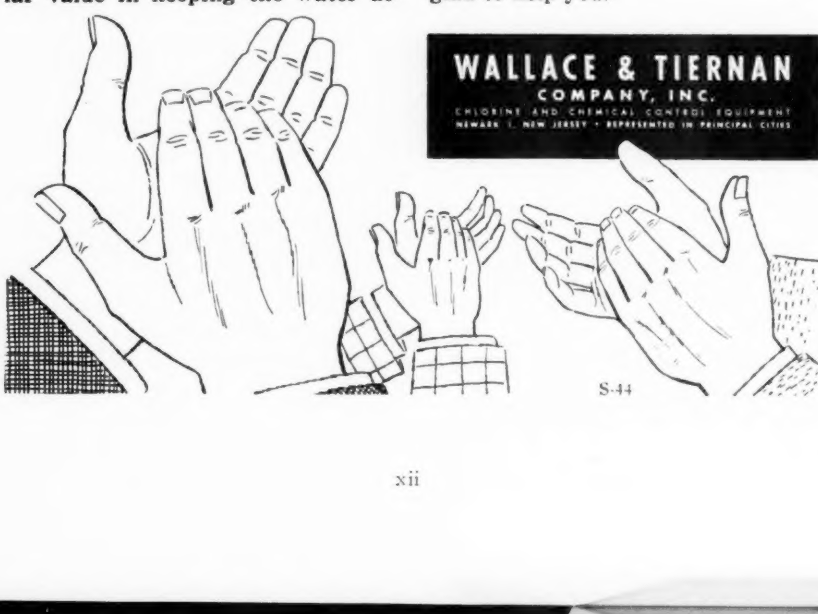

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Journal
AMERICAN WATER WORKS ASSOCIATION
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The Fluoridation of Public Water Supplies

Statement of Recommended Policy and Procedure

A statement approved by the Board of Directors on May 29, 1949, and presented on June 1, 1949, at the Annual Conference, Chicago, by A. P. Black, Chairman, Special Committee on A.W.W.A. Policy re Fluoridation of Public Water Supplies. The other committee members were A. E. Berry; H. A. Faber; R. J. Faust; W. V. Weir; H. T. Dean, Consultant; and L. H. Enslow, ex-officio.

IN COMMUNITIES WHERE A STRONG PUBLIC DEMAND HAS DEVELOPED AND THE PROCEDURE HAS THE FULL APPROVAL OF THE LOCAL MEDICAL AND DENTAL SOCIETIES, THE LOCAL AND STATE HEALTH AUTHORITIES, AND OTHERS RESPONSIBLE FOR THE COMMUNAL HEALTH, WATER DEPARTMENTS OR COMPANIES MAY PROPERLY PARTICIPATE IN A PROGRAM OF FLUORIDATION OF PUBLIC WATER SUPPLIES.

THE results of several carefully conducted epidemiological studies on the relationship between fluoride occurring naturally in communal water supplies and the prevalence of dental caries have demonstrated that the presence of 1–1.5 ppm. of fluoride (F) in drinking water is associated with a 50–65 per cent reduction in caries prevalence. The discovery of this phenomenon engendered the proposal that fluoride be added to communal water supplies as a caries prophylactic measure. This proposal is now being tested in several communities in the United States. A preliminary indication of the full effect of artificially fluoridated drinking water on dental caries will not be forthcoming, however, until children in the test areas have used such waters throughout the enamelification period of the teeth—birth through age eight years for all teeth except third permanent molars.

The water industry is being confronted with demands for the addition of fluorides to water supplies and many utility managements need assistance in handling such demands. Although available evidence supports the hypothesis that fluoridated water will be an effective caries preventative, the evidence is presumptive. It should be remembered, however, that all epidemiological evidence is presumptive.

The value of presumptive evidence depends directly upon the amount and kind of scientific data submitted in support or refutation of the hypothesis advanced.

The water supply industry has always been progressive in matters pertaining to public health and welfare. It has initiated extensive research on subjects pertaining to water quality and has been prompt to adopt new processes and techniques when these have been found to improve the quality of public water supplies. It has cooperated closely with public health agencies. The problem of caries control by the fluoridation of public water supplies has not followed the old patterns which have led to past changes and improvements in water supplies. Whereas public health agencies and the water works industry have generally agreed upon the changes to be made to produce better community health, the present demands for the fluoridation of water supplies are coming from the public and the press in advance of any final decision among public health authorities that artificial fluoridation will be effective against dental caries. The water works industry recognizes these demands of the public it serves and wishes to cooperate with civic and public health authorities, from whom it must receive direction, in the solution of the problem of reducing dental caries.

Lines of Action

The policy and procedure with respect to the fluoridation of public water supplies may, in the light of present knowledge, be broadly divided into two categories: experimental and empirical.

1. *Experimental.* In certain communities the fluoride–dental caries hypothesis is being subjected to experimental verification under acceptable scientific methodology. This procedure obviously necessitates the use of a nearby "control" city with a water supply comparable in all respects to that to which fluoride is being added. The personnel engaged in such studies should include trained dental examiners, epidemiologists, biostatisticians, analytical water chemists, biochemists and other specialists who may contribute to the more complete delineation of the experiment. Examples of this type of study are Grand Rapids, Mich.; Newburgh, N.Y.; Brantford, Ont.; and Evanston, Ill.

One of the factors which further experimental studies may be expected to reveal is what might be termed the climatological or geographical factor. It would be highly desirable to have a number of additional fluoridation studies in different states. These experiments should be so distributed geographically as to provide specific information on the optimal concentration of fluoride needed under particular climatological conditions. It is quite possible that more than 1 ppm. might be required in areas having a low mean annual temperature, such as the Dakotas, while 0.5–0.6 ppm. might suffice where climatological conditions are reversed, as in the deep South or the Southwest.

Additional controlled fluoridation studies, properly distributed geographically, would give direct proof on such points as: [1] the effectiveness of fluoride, [2] the optimal fluoride concentration for different geographical areas and [3] the possible influence, on the fluoride potency, of other chemical constituents of natural waters, insofar as these and other variables may affect the action of fluoride on the control of caries in a human population.

2. *Empirical.* An ever increasing number of communities are willing to provide the cost of fluoridation for the purpose of giving anticipated protection to the oncoming generation of children at the earliest possible time, while awaiting the outcome of controlled experiments.

Although it would probably be desirable from a sound scientific standpoint to await the results of the controlled experiments, the large amount of epidemiological evidence poses an ethical question. This has been well stated by Enslow: "If the process proves worthy of adoption sometime hence, a community denied fluoridation during any period of 'watchful waiting' will have lost the value of the treatment for such period. Neither is it pleasant to contemplate that such loss in tooth protection amongst the youngsters cannot be made up through subsequent water treatment."

Policy

In communities where a strong public demand has developed and the procedure has the full approval of the local medical and dental societies, the local and state health authorities, and others responsible for the communal health, the water departments or companies may properly participate in a program of fluoridation of the public water supplies.

Tentative Recommended Procedure

Recognizing that water fluoridation is still in the experimental stage, it appears desirable to include as part of this report a statement of recommended procedure which may be helpful from a practical point of view.

Sec. 1—Handling Fluoridation Requests

1.1. All requests that fluoride be added to the water supply for the reduction of the incidence of dental caries, which is a public health matter, should be referred to the state (or provincial) and local public health authority.

1.2. The water utility is charged with supplying water meeting standards adopted by the controlling health authority. With regard to fluoride, a maximum concentration of 1.5 ppm. of fluoride ion may be permissible.

Sec. 2.—Responsibility for Fluoridation

Any decision to add fluoride to a water supply should be concurred in by the following authorities and agencies before there is any commitment by the water utility: the local health department, the state or provincial department of health, the local dentists or dental society, the local medical society and the local municipal governing body, board or council. The approval of the state or provincial public utility commission may also be necessary if the utility is privately owned. A ruling should be obtained from the state attorney general; obviously only one such ruling will be required for each state.

Sec. 3—Liability Involved

3.1. The water utility may be liable for damages caused by the fluoridation of a water supply when such chemical is added without specific authorization from controlling health agencies.

3.2. The water utility may be liable for damages caused by negligence in the application or control of the fluoride. The application of insufficient, as well as too much, fluoride might be construed as negligence.

Sec. 4—Steps in Authorization

The operating management of a water supply utility should begin the addition of fluoride in the water supply only after:

4.1. The governing body of the municipality has authorized fluoridation by ordinance, and the local and state health authorities have approved the addition of fluoride and have: [1] established reasonable maximum and minimum limits of fluoride, stated in parts per million, to be maintained in the water supply; [2] approved the type of chemical feeding equipment to be installed and used; [3] approved the installation of equipment, plant layout and methods of handling the fluoride compound to assure the safety of employees; and [4] approved the method of analysis and control to be used in determining the fluoride content of the water before and after the addition of fluoride.

4.2. The state or provincial public utility commission has released, when required, any necessary orders—for example, a method by which the utility will be reimbursed for the expense of fluoridation.

4.3. The legal counsel of the water department or company has made a finding that all necessary authorization has been given to the water utility so that legal liability for damages will be limited to negligence.

4.4. The board of directors or similar governing body of the utility has, by resolution, instructed its proper operating officers and employees to add fluoride as specifically authorized by the controlling health and municipal authorities.

Sec. 5—Disposition of Cost

5.1. The fluoridation of a water supply will increase the utility's operating expense and investment cost. The total cost will probably range from 5 to 15¢ per capita per year, depending upon the amount of fluoride in the supply before fluoridation, the size of the community and the per capita use of water.

5.2. The method by which the cost of fluoridation will be defrayed should be determined before the water utility agrees to the treatment.

5.3. When any authority, such as a public utility commission, has jurisdiction over accounting procedures and water rate charges, the necessary order from such authority should be obtained.

5.4. The cost of fluoridation should not be charged to the cost of water works operation, since the benefits to be derived by the consumer bear no relation to the amount of water used. Although the methods of assessing these charges upon the consumer will vary with the individual utility, the idea should be kept in mind that the cost of fluoridation is a proper charge against communal health activities.

Sec. 6—Items of Cost

6.1. *Investment costs.* The probable facilities and equipment required to add fluoride are: [1] feeding equipment and [2] storage room. (This room may have to be separate from the storage space used for other chemicals, particularly if containers are opened in the room, because of the toxic nature of the chemical. Special ventilating equipment may be required.)

6.2. *Operating costs.* The several operating costs are:

1. Cost of the fluoride, including freight
2. Handling labor or stores costs
3. Operating labor costs.
4. Equipment maintenance costs
5. Laboratory control costs
6. Additional insurance costs, if the legal counsel of the water utility finds that the fluoridation of the water supply may subject employees to occupational disease hazards and the utility to possible damage suits.
7. Investment overhead costs: [1] depreciation expense on structures and equipment; [2] interest or return on investment; and [3] taxes, if any, on the assessed value of structures and equipment.

Sec. 7—Application of Fluoride

7.1. The application of fluoride must be made through accurate feeding equipment. Either gravimetric or volumetric dry-feed equipment or positive-displacement liquid-feed equipment with an accuracy within 5 per cent is required.

7.2. Special precautions must be taken to protect the operators from inhaling fluoride dust when charging the hoppers of the feeders. It is recommended that dry feeders be equipped with dust collectors consisting of bag filters operating under positive air pressure and vented to the outside. Each operator who handles fluoride should be provided with his individual toxic-dust respirator to be used only when handling the chemical. When liquid-feed equipment is used, at least two solution tanks must be available for the preparation and storage of the fluoride solution.

Sec. 8—Control

8.1. Laboratory analysis and control should follow specific instructions from the controlling health authority.

8.2. Samples must be taken from points before and after fluoridation and from one or more points in the distribution system, as determined by the controlling health authority. The frequency of sampling shall be determined by the controlling health authority.

8.3. The method of determining the fluoride content of the water shall be specified by the controlling health authority and shall be in agreement with the latest edition of *Standard Methods for the Examination of Water and Sewage*.

8.4. The results of all chemical tests shall be recorded on forms approved by the controlling health authority and by the legal counsel of the water utility. Water samples for chemical analysis shall be submitted to the state health authority at stated intervals for control purposes.

8.5. The tests for the purity of the fluoride chemical used in water fluoridation shall have the approval of the state health authority. These tests shall include the U.S. Pharmacopoeia tests for heavy metals (U.S. Pharmacopoeia, XII, page 720).

The Public and Rate Increases

By John H. Murdoch Jr.

A paper presented on April 28, 1949, at the New York Section Meeting, Elmira, N.Y., by John H. Murdoch Jr., Vice-Pres. and Counsel, Water Works Service Co., Inc., New York.

IN this paper the author has made an assumption, then established three premises, reached a conclusion and, finally, suggested a plan of action.

It has been assumed that the only water utilities which contemplate rate increases are those whose officers feel that the existing rates are too low to cover adequately the operating expenses and fixed charges while leaving enough net income to assure the financial integrity of the enterprise and enable it to attract such additional funds as it may need for capital betterments and replacements. In brief, it has been assumed that the managers feel the existing rates are insufficient to cover present costs.

Three premises are then established:

1. When the water service being rendered is satisfactory, the public does not object to increases in rates sufficient in amount to cover the entire cost of service.
2. If the water service is unsatisfactory, the public will object to increases in rates even though the proposed increase is only enough to cover increases in costs.
3. Rate increases proposed in connection with acceptable plans to correct faults and deficiencies of plant and service will not be subject to objection.

On the basis of these three premises, the conclusion is reached that the public has more interest in service than in rates. Two plans of action are therefore suggested: First, if the service is now satisfactory but the existing rates are too low under present price conditions to cover all costs and attract new capital to take care of growing demands, then the rates should be increased. Second, if the service is now unsatisfactory and the rates are too low under present price conditions to cover all costs and attract the capital needed to correct existing faults and care for growing needs, it is necessary to prepare plans for improved service and secure increases in rates in sufficient amount to cover all new costs of service.

To avoid misunderstanding, the phrase "cost of service" should be defined. When used in this paper that phrase, or any variation of it, means all operating expenses of the enterprise; all taxes payable; either amortization of debt principal or depreciation; interest on debt; and enough net income to maintain the credit and financial integrity of the enterprise and to enable it to attract needed new capital from time to time.

It should be emphasized that when the author refers to "objection" or uses the phrase, "the public will not object," or similar language, objection by customers is meant, not official objections by utility commissions or other governmental bodies, except

when a popular demand by customers is reflected.

Validity of Premises

How valid are the premises from which the conclusion is drawn? Frankly, they represent the author's opinions based on experience and on observation of the workings of human nature. From a few instances no absolute demonstration can be made that all people will react in the same way under like conditions. At that point opinion takes over. However, it may be worth while to consider several typical situations.

City *A* is served by a water system established more than 60 years ago. In the early days the utility had great difficulty because of industrial contamination of its source of supply, with public opinion supporting industry and with the courts forbidding the collection of water charges until a new supply could be developed. When such a supply was ultimately secured, the courts, after an unpopular fight by the water utility, established the legal principle that contamination of a public water supply constitutes a public nuisance which may be restrained. A program of continued plant development and improvement, well abreast of community growth, carried out by a succession of energetic, efficient and personally popular managers, has changed the old antagonism against everyone connected with the utility into the present attitude of friendliness. Recently it was decided that there was no possibility of prospective increased water usage bringing in enough new revenue at existing rates to overcome the rapid rise in operating expenses and taxes. The utility was not earning its cost of service, with the result that it was having difficulty in getting needed new capital. As there was no possibility of reducing expenses or even of holding them at the current level, an increase in rates was necessary.

The entire situation was laid before local leaders, newspaper editors, members of the city council and other public officials. All were given opportunities for full and open discussion and access to relevant data. The difficulties of the utility and the proposed increase in rates were discussed with the managers of the local industries and their accountants. These men understood their rights and realized their civic and social responsibilties. An increase equivalent to 20 per cent in all rates was approved without protest and the community has continued happy and content.

The service was satisfactory, more revenue was needed and the public did not object to a very substantial increase in rates. Similar instances could be cited to support the author's first premise that: *when the water service being rendered is satisfactory, the public does not object to increases in rates sufficient in amount to cover the entire cost of service.*

At City *B* very different conditions existed. There were two dissimilar sources of supply—a river with hard water and an upland, impounded, soft water supply. The first was filtered and softened but the quality of the water in the river varied radically, often and suddenly. On occasion tastes and odors developed and unsatisfactory water got by the plant and into the distribution system. For one reason or another, almost 10 per cent of the time water with a hardness content well above the standard was delivered to the customers. There were complaints of

turbidity in the distribution system, although plant records indicated that no water with excessive turbidity had been delivered into the system. Water from the river source reached parts of the city at all times and other parts of the city at certain seasons and certain hours. Still other areas had the soft mountain water continuously. Some customers were well satisfied with the quality of the water while others were completely discontented.

The city covered a territory of high hills and deep valleys with very steep slopes between. The water distribution system included a series of districts with elevated storage and booster pumps. The city grew rapidly during the war and has held and increased its population. In several different sections, consumers' water demands had outgrown the carrying capacity of the mains. Especially at the upper edges of the low-service district, along the steep hillsides, there was a lack of pressure. The dividing line could not be moved downhill by a mere change in the location of the valves because the mains into the high-service district did not have the required extra capacity to carry the loads which would have been added.

The situation would not have been difficult if the water utility could have financed various indicated improvements, but the fact was that operating expenses and taxes were absorbing almost all of the revenues. Less money was coming to net income than twenty years before, while since that time investors had put about $1,000,000 of new funds into the system. Much more new money was needed for extensions into newly opened residential districts —not real estate developments of promoters—as well as for the strengthening and improving of the pumping station, the treatment plant and the distribution system in the older sections.

When an increase in rates was proposed, determined opposition developed. It was not claimed that the suggested rates would impose a hardship on customers but that they were too high for the kind of service being offered. The answer that the community was not even paying the cost of the service it was getting, which was the fact, did not lessen the objections. The outcome was the approval of the proposed rates coupled with the condition that an ambitious program of system rehabilitation and improvement be inaugurated at once.

This situation is an example of unsatisfactory service and public opposition to a rate increase designed merely to restore former net-income ratios. The opposition was caused by and centered upon the poor service, not on the dollars and cents involved in the new rates. This and similar experiences form the factual basis for the author's second premise: *if service is unsatisfactory, the public objects to increases in rates even though the increase is only enough to cover increases in cost.*

City *C* presents another typical situation, although in extreme form. The water system serving this city was established about 70 years ago in an old but steadily growing community. Because the city is located at the crest of all the watershed divides in the district, there are no large streams within reach and no substantial ground water supplies are available. Water works engineers and financiers who had been successful elsewhere tried for more than ten years to develop a dependable sup-

ply and, after repeated failures, gave up in disgust. The people of the town had grown to expect periodic curtailment of supply and high turbidity. A group of local businessmen took over, invested their money in large impounding reservoirs on small streams and in one of the very early rapid sand filter plants in the country—a plant still rendering splendid service. Every service was metered and water rates were increased. Within two years after the change in control the city had adequate and satisfactory water service and the company had become a financial success. The people of the city were perfectly content with the new higher rates for water; they were receiving service which they had despaired of ever getting.

All went well for twenty years and then real trouble arrived. The management, lulled into a sense of security by what later proved to be a glaring engineering overestimate of storage reservoir capacity, failed to give weight to evidences that the growth of the city was exhausting the available storage. When drought struck, there was no reserve storage, and on Christmas Eve the state department of health took control and severely rationed domestic use, shut off industries and held the distribution reservoir in readiness for fire. It was months before normal usage could be allowed.

A new manager with good engineering training and experience was secured. He developed plans for increased storage in impounding reservoirs to assure adequate supplies for several years of continued growth of demand. Armed with these plans, he and the other officers carried through a program for increased rates designed to meet the entire cost of service. Although this campaign had to be undertaken against a background of well deserved antagonism to the management, it was found that a frank presentation of all the facts to the leaders of the community resulted in a spirit of goodwill and cooperation. The head of the largest industry and the one hardest hit by the proposed rates studied the figures and then stated that he would rather pay more money for an assured supply than have cheap water with the risk of plant shutdowns. The rates were increased, the improvements were made and the enterprise has been able to give good service during a drought and grow with the community. The people want water service and are willing to pay what it costs, which bears out the premise that: *rate increases proposed in connection with acceptable plans to correct faults and deficiencies of plant and service will not be subject to objection.*

Public Relations

It appears logical to conclude from these three premises that *the public has more interest in service than in rates.*

The author is firmly convinced that water works men have made several mistakes in their relations with the public: [1] not knowing the costs of service; [2] not educating the public concerning these costs; [3] thinking about and advertising cheap water rather than valuable service; [4] trying to persuade the customers that they should not expect better service because they pay so little that the utility cannot afford better service; [5] treating the customers as though they were patrons of a bargain basement clearance sale when they really want a superior prod-

uct and are ready and willing to pay the cost.

Many water plants today have such low rates and high capital costs per average customer that each new customer is a drag on the system rather than a source of strength. This condition is against the public interest, and management should study the economics of its undertakings, consider and work out the true costs of service and then educate the community in these matters.

If a system is giving all the water service the people want and its revenues are now entirely adequate to cover the costs, so that the money required for improvements and extensions is always available, then a rate increase is not needed. It is necessary merely to be alert and keep abreast of the changing times. Experience teaches, however, that many managers are in ignorance of the extent of public dissatisfaction with the water service. A genuine study should be made to learn the true facts.

The management of a system which has been giving satisfactory service but which is not now receiving sufficient revenue to cover present costs should boldly go after increased rates. Higher rates should be sought, not because the utility is entitled to them—as it is—but because the customers need the service which can only be continued if completely adequate revenues are available. The public will not object if the facts are sound and a good job of salesmanship is done.

A plant where the service is unsatisfactory, deficient in one way or another or perhaps in many ways has a much harder task to perform. The author suggests a study of the entire situation by experts—engineers, chemists, bacteriologists, geologists, public opinion analysts, bankers and lawyers. It is necessary to know what the people think they want in the way of service. Then the management will have to find how much this service would cost in capital funds and operating expenses. The bankers and public opinion analysts will be able to say what annual revenues would be required to make it possible to raise the capital funds and whether the customers are really anxious enough for the service to pay that kind of money. Perhaps plans will have to be modified to bring desire in line with willingness to pay. The public and its leaders must be consulted, and, in the end, the plan must be one in which the community has pride and which it will support.

The public objects to paying for unsatisfactory service. It wants good service—better, often, than is now rendered. Once it understands the facts, the public is willing to pay the cost.

Rate Revision in the Light of Present Costs

By Maurice R. Scharff

A paper presented on April 28, 1949, at the New York Section Meeting, Elmira, N.Y., by Maurice R. Scharff, Cons. Engr., New York.

BEFORE dealing with some of the problems of water rate revision, it seems appropriate to discuss briefly whether any distinction should be made, in this connection, between municipal and privately owned utilities. The author has always believed that a reasonable rate is a reasonable rate whether it is charged by a private utility or a municipal corporation. It is just as reasonable for a municipal utility to adjust its rates in the light of present costs—to secure a fair contribution from the customers toward the relief of taxpayers and to avoid a subsidy to the former at the latter's expense—as it is for a private corporation to seek a reasonable return for its investors. Indeed, many municipal water systems, struggling to meet rising costs and to secure adequate wage scales for their employees, appear to be missing a bet if they do not undertake such adjustments.

The Appellate Div. of the New York State Supreme Court, in *Village of Tupper Lake* v. *Maltbie* (257 App. Div. 753, 258 App. Div. 1030; 32 P.U.R. (N.S.) 32, 35) stated: "It is indisputable that as a matter of law a municipal utility is entitled, the same as a private utility, to a reasonable return upon all of its property used and useful in the public service."

This principle for municipal gas and electric utilities, whose rates are subject to the jurisdiction of the New York Public Service Commission, merely restated the decision of the Appellate Div., affirmed by the Court of Appeals, in the Boonville case (*Village of Boonville* v. *Maltbie,* 245 App. Div. 468, 272 N.Y. 40). And it has been double-riveted into New York law for municipal water utilities, whose rates are not now subject to commission control by the adoption of Sec. 18 of Article III of the 1938 state constitution:

> The legislature shall pass no bill, resolution or other measure prohibiting any municipal corporation operating a gas, electric or water public utility service from making and receiving, in addition to an amount equivalent to taxes which the said service, if privately owned, would pay to such municipal corporation, a fair return on the value of the property used and useful in such public utility service, over and above costs of operation and necessary and proper reserves, or prohibiting the use of the profits resulting from the operation of a public utility service for the payment of expenses or obligations incurred by such municipal corporation for municipal purposes, or prohibiting the use of such profits for the payment of refunds to consumers.

Basis of Plant Value

Turning now to the basis of plant value to be used in making rate adjustments, it may be of interest to note that there are still some states, like Pennsylvania and Ohio, where the fair-value

doctrine is embodied in the statutes as they have been applied and interpreted by the courts of these jurisdictions. In such states there can be no question of the advantage and justification for a privately owned water utility to approach the problem of rate adjustment on the basis of a fair return on the fair value of the property used and useful in the public service. And in these jurisdictions, it is the author's opinion that a municipality owning its water system, and being hard-pressed for sufficient public revenue to meet municipal requirements, would be well advised to adopt exactly the same point of view. Certainly, real estate interests and industries, which operate for private profit, are entitled to no subsidy in the form of water rates lower than the reasonable value of the service. Moreover, homeowners are also taxpayers (as, indeed, tenants are, indirectly) and their tax burdens for the same municipal services can be lightened to the extent that the municipality earns a return on its water works property.

In a number of other states, including New York, the regulatory commissions have tended to restrict rate adjustments to levels corresponding with a return on original cost less accrued depreciation, measured by the group straight-line age-life method. It has been widely argued that this standard has been upheld by the U.S. Supreme Court in the Hope Natural Gas Co. case and other recent litigation. Even in these states, however, the issue is not yet a closed one and the opportunity is still open to a company or municipality to establish in the courts the right to earn a return on the fair value of its property by rates which correspond with the reasonable value of the service. In view of the language of the section of the state constitution previously quoted, it might readily be easier for a New York municipal water utility to establish this right than for a private water company. Space does not permit a full development of the argument on this point, but those interested are referred to a recent paper (1) by the author.

In the author's opinion, the contention has not been proved that the Hope Natural Gas Co. decision and the related rulings in the Natural Gas Pipeline, Panhandle Eastern and other cases destroyed the standards for rate regulation previously prescribed by the U.S. Supreme Court in *Smyth* v. *Ames*. It is true that many rate-making orders have been upheld on original-cost and prudent-investment bases when the companies affected have failed to carry the burden of proof that the orders were confiscatory. But, if, as Justice Jackson said in his dissenting opinion in the Hope case, rate regulation is to be the performance of an economic function and not a legalistic ritual, fair rates are still rates that correspond with the fair value of the service; and the value of utility property, if it must be determined, is the present worth of the amount available for return *of* value and return *on* value after subtracting operating expenses other than depreciation from the revenue corresponding with such fair rates.

Notwithstanding these considerations, it has been found that, in states whose commissions have adopted the original-cost basis of regulation and whose legislatures and courts have not specifically prescribed a fair-value rate base, most water companies and other utilities have preferred to accept what they think they can get in the way of rate adjustment without too much trouble and delay rather than assume

the burden of establishing their rights. There is no doubt that the difficulty of proving the value of the service, or the value of the property, in such a way as to make it conclusive against the contentions of a public regulatory body is very great indeed—perhaps so great as to justify the decision that most companies have arrived at when the question has arisen under these circumstances.

Rate Adjustment Procedures

Assuming that it has been decided to base rate adjustments upon a return on the original cost less accrued group straight-line age-life depreciation, certain procedures should be followed.

There is first the problem of establishing a reasonable rate of return to be applied to an original-cost-less-depreciation rate base, for the purpose of determining revenue requirements. Many students and writers on rate of return agree that the question of its reasonableness depends on the rate base to which it is to be applied. Thus, with a rate based on current reproduction costs, the supporters of the "capital attraction" theory of rate of return would apply a weighted average rate required to support a reasonable capital structure necessary to finance such a rate base.

But the most persuasive argument for the original-cost rate base is the contention that it is equitable as between investors and customers. If an original-cost rate base is to be used, there would certainly be no equity in applying to it the same average rate of return as would be applied to a reproduction cost base. For, although it might be argued that the bondholders and preferred stockholders would be equitably provided for by the contractual rates to which they had agreed in consideration of their prior claims on the earnings, such a return at present price levels would subject the common stockholder to a major reduction in the purchasing power of the earnings that would be available, on this basis, for his investment.

If the purchasing power of the earnings available for the common stock were to be maintained, it would be necessary to provide, in addition to interest on the bonds and dividends on the preferred stock, a substantially higher rate of earnings on the equity investment than would be required to attract new equity investments, resulting in a substantially higher average return on the original-cost rate base than would be reasonable for a reproduction cost rate base. Only such an equitable adjustment of the rate of return can support the claim of equity for an original-cost rate base and maintain fairly the relative interests of old and new common stockholders.

Cost allocation is another problem in connection with rate adjustments. Public service commissions throughout the country have been showing an increasing interest in recent years in cost allocation, and the New York commission has been a leader in insisting that rate adjustments must be supported not merely by showing that increased revenue is required but also by proof that the rates proposed distribute such required revenue equitably among all classes of customers in reasonable relation to their respective costs of service. Thus, *In re Brooklyn Borough Gas Co.*, decided August 6, 1947 (70 P.U.R. (N.S.) 33), the commission said:

> The burden of proof established by law is not limited to the proof that increased

revenues are needed but that the rates to be paid by the public are in themselves just and reasonable. In practically every case, the company has completely failed to meet the statutory requirements and, generally speaking, they have made no effort to go beyond the need for more revenues. Consequently, the Commission has no alternative but to provide for temporary rates which will produce increased revenues and give the companies further opportunity of meeting the statutory burden of proof and, through our own staff, make an analysis of the company costs to determine to what extent the alleged increases prove to be needed by actual experience and how the increased revenues should be raised.

The staff of the Water Bureau of the commission has taken the position that it will not approve rate adjustments by blanket percentage increases of existing tariffs without a review of the relationships between the individual rates in the existing tariffs and consideration of whether these relationships correspond reasonably with relative costs of service.

Need for Information

The cost of water service to the various classes of customers is not so much affected by demand, consumption and load characteristics as by the cost of electric service, the variations in which cannot be equalized by storage. Nevertheless, much more complete information than is now available regarding the demand, consumption, load factors and diversities of different classes and sizes of water customers would be invaluable to the industry and to the Public Service Commission for cost analysis and rate design purposes on metered systems.

The collection and pooling of information for these purposes is even more important in those systems which still have large numbers of flat-rate customers. Although catalog ratings and published assumptions are available on the demand, consumption, load factors and diversities of various types of fixtures, there is a great dearth of information based on actual measurements. It is, therefore, practically impossible, when large numbers of flat-rate customers are involved, to propose any apportionment of cost of service which the commission would not be free to reject if the results did not correspond with the ideas of its own staff.

The staff of the Water Bureau of the commission should be highly commended for its work in developing reasonable standards of relationships between the demands and consumptions of various types of flat-rate fixtures and various meter sizes and metered-consumption blocks; and for being willing at all times to sit down with representatives of the industry and work out the reasonable application of these relationships to the design of tariffs adapted to produce required amounts of gross revenue. The author strongly recommends that any system which is considering rate adjustments in the light of present costs discuss these matters in detail with the staff of the Water Bureau before filing new rate schedules or applications. There is also an extensive field for cooperation between the water utilities and the staff of the commission in supplying actual information regarding the load characteristics of both metered and flat-rate customers.

A third problem that is always of importance in connection with rate adjustments is the question of what constitutes a reasonable amount of apportionment to total cost of fire protection service. Since consumption is almost

negligible and the cost consists almost entirely of the provision of plant capacity and readiness to serve, a wide range of results can be obtained, according to whether the calculations are based on the ratios of noncoincident or coincident maximum demands, separate or incremental plant costs, average demands per unit of area and so forth. Depending on which of these various bases of computation is used, estimates made for the same system can run all the way from 10 to 50 per cent of the fixed costs of readiness to serve. Again, there is opportunity for cooperation between the industry and the Water Bureau of the Public Service Commission in the development of reasonable standard bases of apportionment.

Reference

1. Scharff, Maurice R. Valuation and Depreciation of Public Utility Property. Proc. A.S.C.E., **74**:825 (1948).

This Month's Cover

Call it primitive, picturesque or even perplexing, the Acoma Water Hole continues to serve and to survive as one of the oldest public water supplies within the borders of the U.S. As far back as 1540, when the Spanish explorer, Francisco Vasquez de Coronado, paid a visit to the Indian pueblo of Acoma, located some 70 miles west of what is now Albuquerque, N.M., he undoubtedly slaked his thirst here. And for how many centuries before that the hole-to-gourd-to-pot-to-hut system was in operation it is difficult to guess.

What is primitive, of course, is the "system" itself, but even that isn't so simple that there are no problems of carrying capacity, perhaps even head loss. And though the two operators pictured are not now members of A.W.W.A., they perhaps could qualify. At any rate, they themselves lend picturesqueness to the scene, their Sunday costumes blending into their surroundings and perhaps giving added evidence that public water supply is a seven-day-a-week job. Finally, what is perplexing is the apparently floating boulder in the background. Certainly the supply can't be as hard as all that.

The photo used was provided through the courtesy of the Standard Oil Company of California, whose clickmaestro Ferenz Fedor snapped the shot, and was kind enough to give us our heads in describing it.

P.S. *As we go to press, we have cause to wonder whether "civilized" Eastern water works men will not soon be exploring water holes themselves. Add a few more desiccating days of dryness to the already more-than-month-old drought and there'll be good reason to go primitive.*

Use of Geologic Methods in Ground Water Prospecting

By O. S. Fent

A paper presented on April 22, 1949, at the Kansas Section Meeting, Hutchinson, Kan., by O. S. Fent, Cons. Geologist, Salina, Kan.

THE use of geologic methods is not essential in the search for supplies of underground water, and many excellent sources have been found and developed without recourse to them. Similarly, many good mines and oil fields have been discovered without reference to the principles of geology. It would be difficult, however, to name any major oil producer or mining company that is not at present taking advantage of geologic principles in exploration and development work. No phase of municipal activity is more nearly comparable to private business enterprise than the municipally owned and operated water works. Regular business techniques are now being employed in the distribution and service side and are gradually being introduced, through the science of ground water geology, into exploration and production.

The occurrence of ground water is regulated by the nature of the rocks in the subsurface. Its movement underground and into wells and springs is governed by the same laws of gravity and pressure that affect water at the surface. Many facts concerning the depth, quantity and quality of underground water can be predicted through the principles of geology. In ground water exploration, as in oil exploration, the purpose of geology is to eliminate numerous unfavorable areas in advance of any exploratory drilling and reduce the number of holes necessary in the good-prospect areas by geologic interpretation of surface and subsurface data. The object is to gain definite information on the quality and quantity of water with less time and expense in investigation than the old trial-and-error method required.

The importance of locating any drill site geologically is emphasized by the fact that only about 5 ft. out of each 100 ft. of the outcropping, consolidated rocks in Kansas contains suitable water-bearing beds. Unfortunately, these zones are not distributed uniformly so that each 100 ft. of the subsurface contains a 5-ft. aquifer. As an example, the upper 2,500 ft. of Cretaceous rocks in Kansas includes only one 15-ft. zone that is a reliable aquifer. Considering this erratic distribution of water-bearing zones, the importance of knowing the formations that lie in the subsurface and the formation that is to be reached for testing is easily recognized.

The three main tools of ground water geology are stratigraphy, geologic history and hydrology. Stratigraphy is the science of the sequence of layered rocks. By recognizing the formation at the surface the stratigrapher is able to predict the presence or absence of possible water-bearing rocks in the sub-

surface. (The term "rock" is used throughout to mean not only consolidated rocks, usually called solid rock, but also the unconsolidated rocks such as clay, silt, sand and gravel.)

Geologic history is used to predict the nature and extent of water-bearing rocks. Many of the important water-bearing characteristics of the rocks can be interpreted by reference to the method of original deposition and to the modifications of the rock since deposition. Many sandstones are known to be confined to narrow channels because they were deposited by streams following a confined and limited course. Likewise, many limestones are known to have been subjected to fracturing and weathering and transformed from impermeable beds to good aquifers. Conversely, many formerly good sand and gravel zones have been reduced in their capacity to transmit water by the deposition of minerals in the original pore spaces.

Hydrology, the science of the water of the earth, is used to interpret the movement of water into and through a formation and to indicate the quantity and quality of water present.

The correct use of these three tools of ground water geology produces an index of facts and principles that must be applied differently in each separate geologic setting. When properly applied they fit the general definition that has been offered for science: a system of organized common sense.

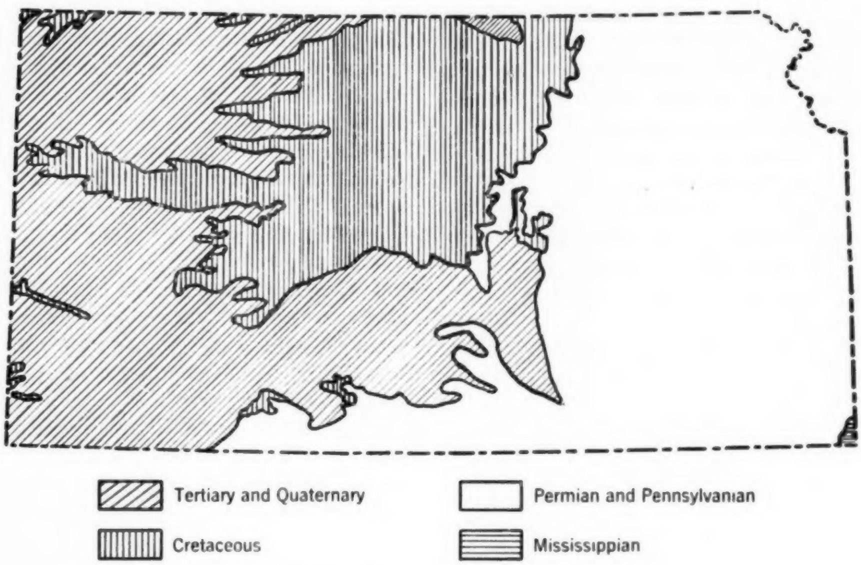

FIG. 1. Generalized Geologic Map of Kansas

Kansas Geologic Formations

By reference to the geologic map of Kansas (Fig. 1), the use of ground water geology in many of the well known aquifers in the state can be demonstrated. In the southeastern corner,

the lower Pennsylvanian formations recognized at the surface allow the stratigrapher to estimate the depth to the limestones of the Mississippian, the dolomites and sandstones of the underlying Ordovician and the sandstones of the Cambrian rocks, which occur at depths as great as 2,000 ft. Many good water wells in this region are 1,000 to 1,700 ft. deep. From the geologic history of the area, it is known that many of the limestone zones have been exposed to surface weathering and solution and have large fractures and solution openings which transmit water freely to wells. It is to these zones or to sandstone zones below them that the wells are drilled. From hydrologic knowledge of the area, the presence of water too highly mineralized for use is recognized in some of the formations, which can be cased off in the completed well. It is also known that the water becomes too highly mineralized for municipal use in all of the deep water-producing zones to the northwest of this area. The line marking the northwestern limit of the potable water in the deeper aquifers corresponds roughly to the outcrop line of the Fort Scott limestone.

Some of the Pennsylvanian sandstones are important as water-bearing zones. The method of prospecting for them differs according to the nature of the deposits as determined by their geologic history or method of deposition. One spacing of test holes is required to test the narrow sandstone zones of the Englevale Channel sandstone, which will show abrupt changes in thickness and character over short distances. Another, wider spacing may be used in testing Hepler, Tonganoxie and similar sandstones, which are more persistent laterally. The approximate depth to these sandstone zones can be predicted by stratigraphic methods when the surface formation is recognized. It is also known that the water in these zones becomes progressively more highly mineralized to the west and north of the outcrop line. One test hole to such a mineralized zone, or a sample from an existing well in the zone that shows high mineralization, should preclude any additional exploratory drilling, except on the side toward the outcrop area. The recognition of the formations encountered in prospect drilling in these areas will prevent much wasted footage. It is obvious that any drilling below the last possible aquifer is needless, and any drilling that extends below one aquifer and does not reach a second is a waste of time and money. Drilling without geologic control is especially likely to include wasted footage in areas where the rocks show local structure and do not occur at the expected depths. Drilling by depth or elevation figures alone may not produce a valid test of the area.

The Fort Riley, Florence and Wreford limestones of the Permian formations are well known aquifers in Kansas. The approximate depth to any one of these zones can be determined by stratigraphic methods, and the history of the exposure and weathering of these rocks in any one locality will provide many clues to their water-bearing characteristics. The irregular nature of the fractures and solution channels may cause great differences in yield in nearby wells. Consequently, several tests might profitably be made in a small area before a permanent well site is chosen. Acidizing to increase the flow from a low-yielding well or test hole is often effective in these rocks because of their soluble nature.

The geologic identification of the Greenhorn limestone or a similar upper

Cretaceous bed along its outcrop in Kansas will be evidence to the stratigrapher that the sandstones of the Dakota formation and the Kiowa shale will be found at known depths in the subsurface. Dakota sandstones are lenticular in nature and occur as channel deposits which may show an abrupt change of thickness or be entirely absent in some areas. With these facts in mind, the geologist must space the test holes to fit local conditions. The same generalization concerning the mineralization of the water to the northwest in Kansas applies to the Dakota and Kiowa formations. Records of wells drilled in the area or nearer to the outcrop zone than the proposed well site may save the expense of further testing.

The gravel of the Ogallala formation in western Kansas is a well known water producer. It does not overlie all of western Kansas and it is not everywhere the surface formation, as is shown on the generalized state map. Its presence or absence, however, can often be predicted by stratigraphic methods. An outcrop of one of the Cretaceous formations naturally proves the absence of the Ogallala since it was deposited later than the Cretaceous and cannot underlie it. The algal limestone occurs at the top of this formation in many places, and, where recognized, indicates that the complete local section of Ogallala is to be found in the subsurface. The regional geologic history may, however, modify plans to explore this formation. It is known that the sand and gravel of the Ogallala were deposited by streams flowing eastward from the Rocky Mountain region and that the formation thins to the east across western and central Kansas. The algal limestone, indicating the Ogallala in central Kansas, might lie above only a few feet of sand and gravel. The entire formation could lie above the water table and be worthless as an aquifer. Its relationship to surrounding outcrops will indicate this condition where it exists.

The unconsolidated rocks of the Pleistocene and Recent epochs, which are excellent aquifers in many parts of Kansas, include the alluvium of stream valleys and alluvial deposits in the glacial material in northeastern Kansas. There are several key beds in the Pleistocene that can be recognized for local stratigraphic correlation. Prominent among these are a zone of volcanic ash, a fossil soil zone, the two glacial till sheets in the northeastern area and, in late Pleistocene alluvial deposits, the separate terrace levels to be observed at the surface. Recent work in Kansas by the Ground Water Div. of the U.S. Geological Survey and the Kansas Geological Survey has improved the knowledge of these deposits so that many precise stratigraphic correlations can now be made in sections formerly considered undecipherable. The relationships of these gravel deposits in different areas of the state and their hydrologic interpretations provide one of the most interesting studies in ground water geology. From the standpoint of quality and quantity of water produced, the study of these deposits can also be most profitable and rewarding to cities and industries seeking dependable sources of supply.

Single-Cycle Valley

The prospecting of most Pleistocene gravel deposits in the state involves the study of valley and channel formation, the simplest type being the single-cycle valley (Fig. 2). A valley of this type contains the deposits of a single stream in one cycle of cut and fill.

Stream erosion has cut out a trough or channel in the underlying bedrock and refilled it with gravel and sand, fragments of the rocks the stream has broken and removed in its upstream, headwater area. Many facts concerning the type of gravel to be expected in any valley in the state may be predicted in advance of test drilling. By noting the rocks through which the stream has cut its course, and knowing the weathering properties of these rocks, the gravel can often be described in advance of field prospecting.

A stream in eastern Kansas with its headwater area in the Florence and Wreford limestones will have a large proportion of brown, rounded flint nodules and white and gray, flat limestone fragments at the base of its channel. A stream in central Kansas with a drainage area through the Cretaceous rocks will have a large proportion of fine sand from the sandstones of the Dakota and Kiowa formations in its alluvium. Mixed with the fine sand will be weathered nodules of red to black ironstone and flat gravels derived from the thin-bedded Greenhorn limestone. This mixture of fine sand and large flat fragments is known to have certain ground water properties that can be predicted in advance of pumping tests. The presence of water of high iron content can also be foretold, adding to the knowledge of the quality of water in advance of sampling and chemical analysis.

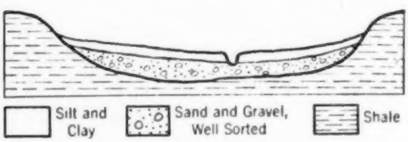

Fig. 2. Single-Cycle Valley

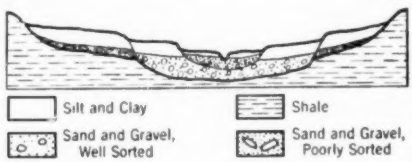

Fig. 3. Multiple-Cycle Valley

If the headwater drainage area of the stream goes back into thick Tertiary deposits, the alluvium will contain much good sand and gravel derived from the Rocky Mountain region. In general, streams with alluvium of this type make the best sources of water in the state.

Salt content is another important factor in the quality of water that can often be predicted in advance of test wells. Where a stream valley is cut through rocks of high salt content, the saline waters can be predicted and steps can be taken to avoid constructing expensive wells that are later ruined by the intrusion of highly mineralized water from the surrounding rocks. Notable in this respect are the areas in central and northern Kansas where streams cross saline zones near the base of the Granerous shale, the Cheyenne sandstone and the Hutchinson salt member of the Wellington shale. Recognition of these potential dangers to municipal wells will often allow the salt water areas to be recognized ahead of time and suggest steps to avoid the unpalatable water. It is frequently possible to construct lower-yielding wells in the thinner parts of the alluvium that will give good water, although other wells in the same valley, located from the standpoint of quantity considerations alone, will produce water that is salty and objectionable.

When water of objectionable quality is not a factor, the exploration of single-

cycle valleys is usually a simple problem of locating the thickest section of the most permeable sand and gravel and determining the correct well spacing by pumping tests and observation wells.

Multiple-Cycle Valley

More common to Kansas is the multiple-cycle valley (Fig. 3), in which there have been several cycles of stream cut and fill. Often the alluvium of one cycle differs appreciably from that of another because of different drainage areas and stream characteristics throughout the history of the valley. In a valley of this type, the surface features which should guide any ground water investigation are the terrace scarps delimiting each type of alluvium. The terraces are often referred to locally as first, second and third bottoms. In the cross section shown in Fig. 3, the alluvium of the highest terrace is composed of poorly sorted sand and gravel of low permeability. This fact will be indicated by mapping the terrace upstream to the source of the sediments and can be confirmed by a few test holes in the area. Much needless test drilling can be avoided by recognizing such terrace deposits and mapping them in advance of actual testing work.

The alluvium of the next lowest terrace in this section is composed of well sorted, highly permeable sand and gravel and is superior to the flood plain alluvium, containing a smaller proportion of fine material. The difference in material deposited in this cycle is due to the same change in the transporting and depositing power of the stream that accounts for the difference in surface level and is outlined by the inner terrace scarp, visible at the surface.

The area for profitable investigation is defined by the two terrace scarps. The inner boundary of the highest terrace and the outer boundary of the lowest outline the material suitable for further investigation. As this fact would probably be discovered by nongeologic methods of prospecting, the only advantage of using geologic methods in the investigation of a valley of this type would be in the smaller number of holes drilled to produce the same results.

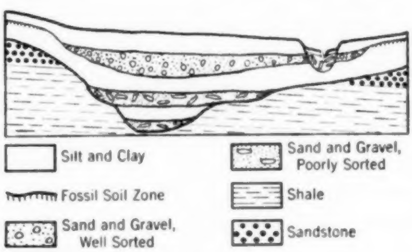

Fig. 4. Buried-Channel Deposits

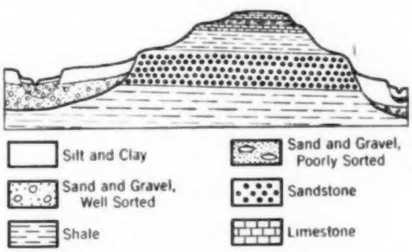

Fig. 5. Interstream Divide Area

In any multiple-cycle valley in which the deposits of one cycle differ from those of another, the water-bearing characteristics of the separate deposits may be ascribed to the factors involved in the drainage history of the area. Loss or gain in transporting power, or in material available for alluvial fill, may be due to river capture—or river piracy—in which one stream flowing at a lower level cuts into another stream by erosion in its headwater drainage area and captures its upstream portion.

The changes may also be due to climatic differences without a change of drainage pattern, or both may occur together. The complex histories of Kansas valleys and their correspondingly complex hydrologic properties are largely the result of the many changes of climate to which they were subjected throughout Pleistocene time. In this epoch major variations occurred in climate from cold to warm and wet to dry, associated with the advance and retreat of glaciers over the northern part of the United States. These changes are reflected in the streams and the type of alluvium deposited throughout this epoch. One of the best known examples of stream changes in Kansas, and one involving the source of ground water supplies for several towns, is the great deviation in the path of the Smoky Hill River, which at one time flowed south through McPherson County and joined the Arkansas River.

Buried-Channel Deposits

Often the separate cycles of a valley are buried channels rather than terrace deposits. A valley in the northern part of the Great Bend Prairie region of central Kansas is typical of deposits of this type (Fig. 4). This valley is a good example of the relationship of hydrologic properties to geologic history and the use of stratigraphic methods in the interpretation of unconsolidated deposits.

The deepest channel in the valley was formed by a short stream eroding Permian, Cretaceous and thin Tertiary deposits. The history of the stream was primarily one of vertical excavation of the rock materials, followed by the deposition of some of the material removed from its short drainage basin. The resulting deposit was a deep, narrow channel fill of material of low permeability. The second channel stage was formed by a stream with a drainage area over similar source beds but flowing toward a higher base level, resulting in a laterally moving stream and a wider deposit of material of low permeability.

Because the material in these separate channels reflects the rocks over which these streams have passed, the approximate upstream path can be determined. From this path, the probable type of material encountered in wells northwest of this area and their approximate yield can be foretold without an investigation of each farm well reported to be a possible source of municipal water. It will be apparent to the investigator that wells in these channels upstream from the section shown in Fig. 4 will make suitable farm wells but would not be suitable to explore for municipal supply.

In the next higher channel an abrupt change in the valley was effected. The stream captured the headwater drainage area of a major stream flowing from the Rocky Mountains (the ancestral Arkansas River), tapping a source of good-quality, granitic gravel. The resulting deposit was a gravel of comparatively high permeability and a good aquifer. The last major stage in the history of this valley involves the loss of the major stream by its recapture through another route and the reoccupation of the valley by a minor stream with a short drainage area that taps no sources of sediment conducive to the formation of a good aquifer.

Knowledge of the conditions at this cross section of the valley and of former drainage patterns allows extrapolation upstream and downstream over paths followed by the streams in different stages of the valley's history and makes it possible to predict the water-bearing

character of the material over much of the region.

A test hole with geologic interpretations extends the known conditions far beyond the actual area of the hole itself. The purpose of geologic interpretation in drilling is not merely to answer the question of whether a specific spot is, or is not, a suitable place for a water well. Recognition of the type of deposit and its relative age permits some predictions of the water-bearing possibilities over a wide area and should determine where the next test hole is to be drilled. Each type of sediment encountered was deposited by one of several agents, the identification of which gives a clue to the nature and extent of the deposit. Thus the stream-deposited material in the large upper channel in this area was from a western granitic source and must have had a particular drainage pattern. Once encountered and correctly interpreted, the course can be mapped by surface indications. The course of the upper channel does not follow that of the lower two. The section shown in Fig. 4 is the **X** formed where these channels crossed.

Geologic or stratigraphic interpretations should also be applied while the hole is being drilled. Certain key beds in the unconsolidated Pleistocene deposits can complete the information on a test hole before the base of the unconsolidated material is reached. In this valley, a bed of volcanic ash dates the second lowest silt section. This material is older than the only aquifer suitable for municipal supply in the area and the test hole can be stopped when it is reached, saving the extra 80–100 ft. of drilling necessary to reach the base of the channel.

In an area with a different drainage history this key bed may be underlain by excellent water-bearing strata. The difference in the test procedure followed should depend upon the geologic history of each separate drainage basin.

Another interesting and useful key bed in this section is a prominent fossil soil zone called the Loveland soil. Locally this zone is only 3–7 ft. below the surface and can be identified in road cuts and shallow auger holes. This soil is developed in material older than the only suitable gravel in the area and cannot overlie it. Consequently, where Loveland soil is observed, the best aquifer in the region cannot be present. Like the volcanic ash, this soil in the area under discussion indicates unfavorable ground water conditions, but in drainage basins with a different history it may overlie excellent aquifers.

These two key beds are good examples of the use of geology while the investigation is in progress and of the relation of geologic history and stratigraphy to ground water prospecting in unconsolidated material.

Practical Importance

Often the problems of ground water prospecting involve both consolidated or bedrock and unconsolidated rocks or loose earth materials. An investigation of such an area, without geologic interpretation but with a very careful collection of nongeologic data, was conducted by an industry for the purpose of locating a plant that needed a great deal of water of good quality. The general area chosen for the plant site was above the junction of a river with a small tributary stream. Five terrace levels constituted the divide area between these two streams. Large irrigation wells were known to have been successful on the two lowest levels near the river where the soil and topography were suitable for irrigation.

Domestic and farm wells were found on all levels and were reported to be satisfactory sources of water at all seasons. Coarse gravel was exposed at the surface below the fifth level. All wells were reported to end in sand or sand and gravel, and the water-bearing material was therefore assumed to be of a similar type over the entire divide area between the two streams. Attention was then directed to the quality of water on the five levels. Samples were collected from existing wells over the entire area and analyzed for chemical impurities. It was found that the best quality of water was obtained from wells on the fifth level, at the center of the divide area. Construction of the plant was begun and a well was drilled which yielded less than 100 gpm., as compared to the 1,000 gpm. expected from the records of irrigation wells in the area. Despite the extensive survey of ground water conditions and the chemical analyses made, the money spent on the investigation and on the well was lost because of the incorrect corelation of the materials across the divide.

A knowledge of the complete geologic section in this area (Fig. 5) would have eliminated the upper three levels as good ground water prospects. Actually the wells "ending in sand and gravel" on the third, fourth and fifth levels ended in the sandstone of the Dakota formation, which, because of its friable nature and the alternation of soft and brittle beds, resembles sand and gravel in drill cuttings. The gravel observed at the surface below the fifth level was a thin Tertiary deposit, lying entirely above the water table and completely unrelated to the gravel of the first and second levels. The algal limestone, one of the key beds in this section, could be observed above the gravel. A thin remnant of the Greenhorn limestone was exposed at the base of the fourth level. This material, of Cretaceous age, should have proved the impossibility of gravel deposits in the upland wells that were reported to have encountered them.

The only parts of the area which could yield sufficient water from a small number of wells were the first and second levels, underlain by Pleistocene sand and gravel. The correct geologic correlation of the aquifers or the recognition of the difference between the rock terraces and the cut-and-fill terraces of the river and small stream would have prevented a costly mistake.

Summary

In summary, the purpose of geology in the search for ground water supplies is: [1] to delimit the unproductive regions and concentrate the investigation in those areas where the possibilities of a satisfactory supply are good; [2] to identify the water-bearing beds or ascertain their presence or absence in order to avoid the drilling of unnecessary footage in test holes and wells; and [3] to determine, by geologic interpolation and extrapolation, the nature of the material between the holes drilled and extend the information beyond the actual testing area.

In the search for ground water, as for oil, gas or other mineral deposits, geology is not a miraculous method that exposes all of the secrets of the earth to view, but it is an efficient system of eliminating much of the uncertainty of underground exploration.

Chicago South District Filtration Plant

By John R. Baylis

A paper presented on May 30, 1949, at the Annual Conference, Chicago, by John R. Baylis, Engr. of Water Purif., South Dist. Filtration Plant, Chicago.

SEVERAL features of the Chicago South Dist. Filtration Plant are now attracting attention, the most important of which is the operation of filters at high rates. This was made possible by the development of means of toughening coagulation at the experimental filtration plant in 1937. In the new plant, ten of the 80 filters are being operated at rates of 4–5 gpm. per square foot. This experience is paving the way to setting a figure of 3 gpm. as the rated capacity of rapid sand filters.

Figure 1 is a general layout of the plant, showing the relation of the filters to other parts of the plant. A section through one of the filter galleries and two filters is illustrated in Fig. 2. A number of items of filter design differ from the usual practice: [1] The sand level is 7.7 ft. below average water level on the filters; [2] the filter manifolds are of concrete and are larger in size than those generally used; [3] the filter rate controllers have Venturi tubes of special design with a long recovery cone and one butterfly valve; [4] a pneumatic telemetering system is used to actuate the rate-of-flow, loss-of-head and sand expansion gages located on the operating table; [5] the underside of each wash water trough is flat and level, so that it is a uniform distance above the sand; [6] the filters are provided with surface wash systems of fixed-jet type; [7] sand expansion devices record on a chart the expansion during backwashing; [8] steel four-way plug valves are used on the operating table manifolds; [9] flexible shafts are used instead of cables to transmit valve position to indicators on the operating table; and [10] a cotton plug filter is attached to the effluent of each filter.

Other features of design are not unusual. Each filter has an area of 1,389 sq.ft. The wash water gutter is to one side and does not divide the filter in two as is the common practice for large filters. The filter is composed of 24 in. of sand of 0.65-mm. effective size. The underdrains are 4-in. cast-iron pipes, spaced 1 ft. apart. The filter influent piping is 30 in.; the effluent piping, 20 in.; the backwash piping, 30 in.; and the drain piping, 42 in.

Design Based on Experiment

The design of the South Dist. Filtration Plant carries out in large measure those deviations from prevailing practice indicated as desirable by the experimental work conducted between 1927 and 1939. From the beginning of the operation of the experimental filtration plant until 1937, all tests showed that rates of filtration above the customary 2 gpm. could not be used safely and that this rate would not produce water of high quality at times in the winter months. In 1937

a method of strengthening the coagulation was developed which assured a good quality of water not only at the 2-gpm. rate, but at rates much higher. It is well known that many plants have used filtration rates in excess of 2 gpm. during periods of peak demand, which generally occur in the summer. The winter months are the most troublesome from the standpoint of water quality in the majority of filtration plants, yet operating records in plants throughout the country generally do not disclose any difference between winter and summer turbidities of the filtered water. It is likely that sensitive tests are usually not made, although there are, no doubt, some plants not troubled with weak coagulation.

The passage of at least some coagulated matter through the filters during periods in the winter, if not universal, is widespread. Plants handling Lake Michigan water are no exception to the general rule, as was fully demonstrated in the experimental plant. With an effective sand size of 0.50-mm. diameter, filters operated at a 2-gpm. rate passed coagulated material readily when the water temperature was low. As shown in Table 1, the passage was occasionally so great that the water would not have been satisfactory to many users. Up to 25 per cent of the coagulated material going to the filters was passed during very bad periods. Tests indicated that the sand would have to be below 0.35-mm. effective size to prevent the passage of any coagulated matter. Sand of this size would be entirely too fine for summer conditions in Chicago.

Prior to 1937 the author was reluctant to set a filtration rate for the Chicago filters in excess of 2 gpm. Faced with the facts shown in Table 1, the reason for this reluctance is apparent. After perfecting the method of strength-

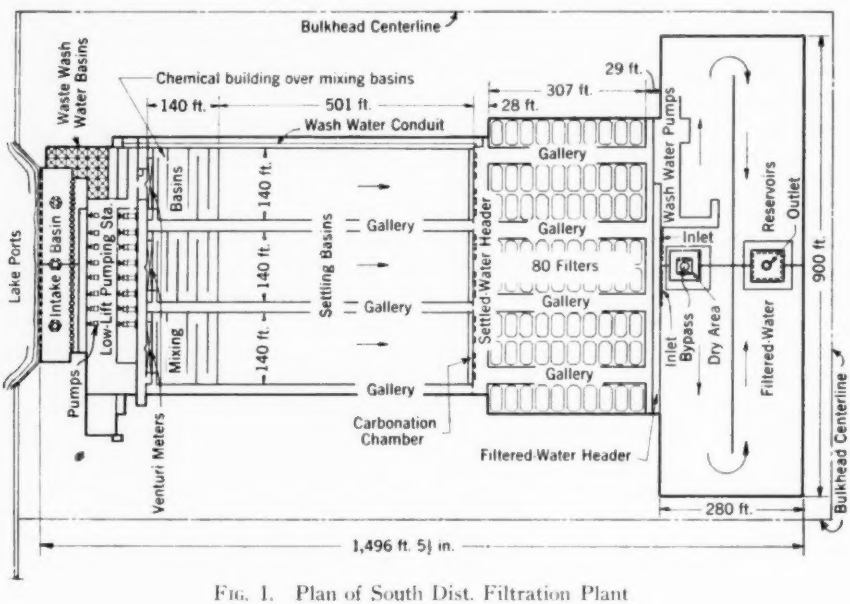

FIG. 1. Plan of South Dist. Filtration Plant

ening coagulation, the designers of the large filtration plant were told they could use rates of 2.5 gpm. for the winter months and 4 gpm. for the summer. Shortly afterwards advantage was taken of these higher rates when it was decided to have three instead of two pumping stations supplied by the filtration plant. Construction work was under way on the large plant when this decision was reached, yet no increase in plant size was made because of the assurance that higher rates of filtration could be used safely. The experimental data indicated that rates higher than 2.5 gpm. could be used in the winter, though it was deemed advisable not to depend too much on tests with small size filters.

Description of Filters

The 80 filter tanks at the South Dist. Filtration Plant are each 53.9 ft. long, 29.55 ft. wide and 13.5 ft. deep (inside dimensions). A wash water gutter 3.08 ft. wide, with an 8-in. concrete wall, extends the full length of the tank, leaving an area 25.8 ft. in width for the sand. The reason for the 13.5-ft. depth of tank, which is greater than that commonly used, is to avoid air-binding of the filters. The Lake Michigan water is saturated with air practically all of the time, so that any negative head in the sand layer when the loss of head is high may release air in the bed. Almost no trouble from air-binding is being experienced.

The filters are equipped with 4-in. cast-iron underdrains, spaced 1 ft. apart center to center, and have holes in the underside 6 in. apart. The holes were formed by drilling $\frac{1}{2}$-in. openings through the cast iron and lining them with brass eyelets. The diameter of the hole after lining is approximately $\frac{7}{16}$ in. A 4 × 6-in. tee connects the underdrain to the manifold along the centerline of the filter.

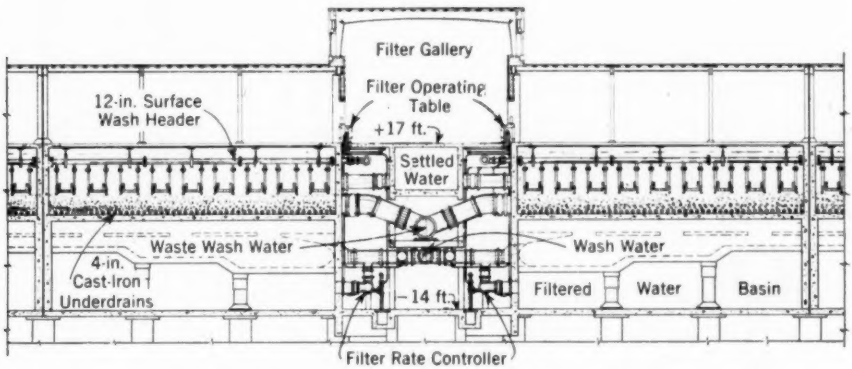

FIG. 2. Section Through Filters and Filter Gallery

Each filter is composed of 21.5 in. of gravel in six layers of various sizes. The sand layers are 24–25 in. in depth, with the effective size of the sand averaging 0.65 mm. Both the sand and gravel were obtained from Muscatine, Iowa.

Figure 2 shows a longitudinal section through two filters in which the shape of the filter manifold is disclosed. The inside width is 4 ft., and the area is larger than that generally used for filters of this size. The shelf arrange-

ment that produces one channel above the other with three openings between the channels is unique in manifold design. Since a low rate of backwash is being used, the large size is of no special advantage. The author does not know all of the facts that led to this design but assumes the purpose was to provide ample area for high-rate backwashing.

A section of the wash water trough and two surface wash laterals supported by it are shown in Fig. 3. Each filter has nine troughs spaced 6 ft. apart center to center. The unusual feature of the design is the flat bottom with a level underside throughout its length. In addition to ease of construction, the aim was to produce a design that would aid in washing filters clean in a short time. In observing the backwashing of filters in various filtration plants, the slowness with which the water clears as the backwashing continues has caused the author to wonder if improvement could be made by modifying the shape of the trough. Washings have often been noticed in which clear water is overflowing into the troughs, while between the troughs there were quite turbid areas that required some time to clear. Just how successful the present effort to produce quicker flushing away of the turbid water has been cannot now be answered, for there is no filter with a conventional type of wash water trough to serve as a standard of comparison.

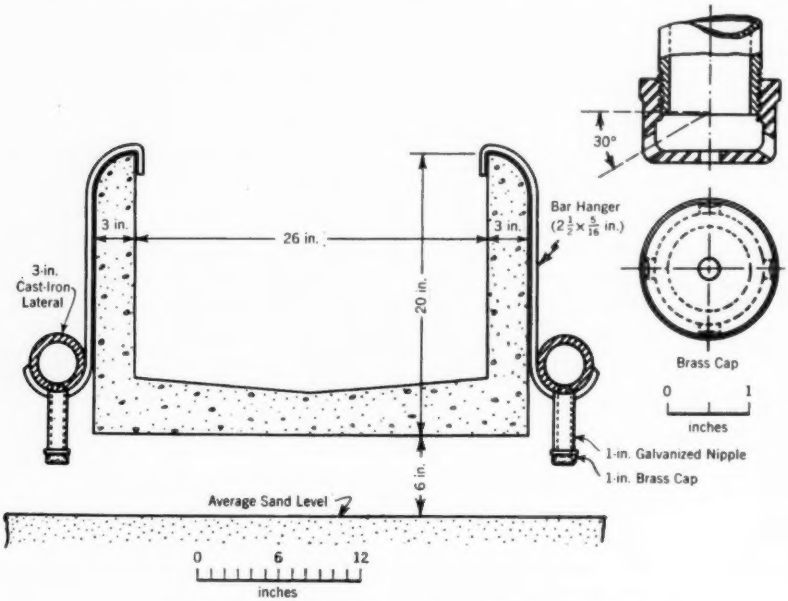

Fig. 3. Wash Water Trough and Surface Wash

The practice in the design of wash water troughs heretofore has been to use the smallest trough that will carry away the waste wash water. The design for the Chicago filters may be said to follow the prevailing practice in this respect, as the troughs used are none too large. The time may be not far

distant when wash water troughs will be designed with regard to outside shape and may be much larger than necessary for carrying away the water.

Early studies indicated that the bottom of the troughs should be approximately 8 in. above the sand. Later the design was changed to 6 in. Based on present experience with the troughs in the large filters, the 8-in. distance above the sand would have been better.

With a **V**-shape or round-bottom trough, the tendency is to produce more rapid velocity of the water against the sides of the troughs than in the area midway between them. Sometimes the water appears to be flowing downward in the middle region instead of upward.

It was hoped that in the design shown in Fig. 3 the horizontal velocity flowing from underneath the troughs each way would be sufficient for the flow from one trough to extend over to the midsection where it would meet the flow from another trough, thus producing a slight boiling effect near the midsection instead of along the sides of the troughs. This hope has not been fully realized, yet some improvement has been made. More study will be given to trough design with the objective of aiding filter washing and not the mere production of the smallest-capacity section required for taking away the waste water.

The surface wash piping, which connects to the wash water tank separately from the backwash piping, is 24 in. There are two 16-in. headers in each of the four filter galleries, with 12-in. laterals that serve the filters. Each lateral extends through the filter wall and along the side of the filter 4 ft. above the tops of the wash water troughs. The lateral becomes a header for eighteen 3-in. cast-iron laterals that extend across the filter $1\frac{1}{4}$ ft. below the top of the troughs. Each lateral has six 1-in. galvanized pipes, 5 in. long, screwed into threaded holes spaced 3 ft. $2\frac{3}{8}$ in. apart and pointing downward. Screwed on the end of each pipe is a 1-in. brass cap, drilled with five $\frac{1}{4}$-in. holes. Four of the holes are slanted

TABLE 1

Turbidity and Floc Volume—Experimental Plant Filter

FILTER DATA

Filter size	10 × 10 ft.	*Rate of Operation*	2 gpm./sq.ft.
Sand		*Aluminum sulfate*	7.2 ppm.
Depth	24 in.	*Mixing time*	27 min.
Effective size	0.50 mm.	*Settling time*	3 hr. 6 min.

Date (1930)	Time in Service *hr.*	Turbidity		Head Loss *ft.*	Floc Volume*	Effluent Turbidity†
		Raw	Settled			
Jan. 13	0	39	25	1.5	0	0.0
	7		25	1.8	1.0	0.1
Jan. 14	24	42	26	2.8	52.0	3.5
	31		26	3.4	96.0	6.4
Jan. 15	49	25	17	4.6	80.0	5.3
Jan. 16	73	66	22	6.7	70.0	4.7

* Volume of coagulation per million volumes of water.
† Computed from floc volume.

downward at an angle of about 30 deg. to the horizontal. The fifth hole points straight downward. Figure 3 shows details of a surface wash cap.

The design of the holes in the brass caps was based on work with surface washes at the experimental plant in which the angle of the holes was 38 deg. to the horizontal instead of 30. The holes in the caps at the experimental plant were drilled from the inside, whereas the holes for the South Dist. Filtration Plant were drilled from the outside, leaving burrs around many of the holes on the inside, which were not removed in installing the caps. As a result, the angles of the jets of water are 10–35 deg. to the horizontal instead of being about 30. Some of the nearly horizontal jets therefore kick up sand, and, to avoid loss, the surface wash at present is used only 30 to 60 seconds at the beginning of the wash while the sand is being expanded.

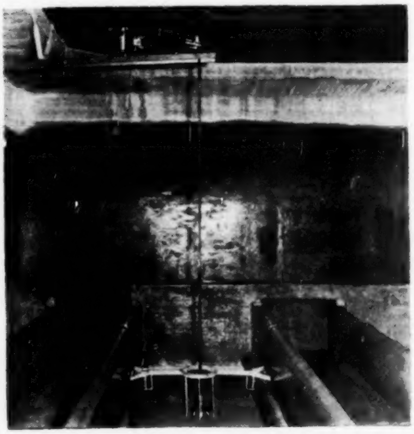

FIG. 4. Sand Expansion Transmitter

In one of the filters, the holes in the caps were drilled from the inside with a $\frac{7}{32}$-in. drill at an angle of approximately 40 deg. to the horizontal. On this filter, the surface wash is used throughout the washing operation and is cut off just in advance of the backwash. The direction of the jets of water is close to the intended angle and no sand is lost. Since the present short period of surface washing prevents mudball formation, there appears to be no need of changing the brass caps in the other filters.

Recording and Control Equipment

A photograph of one of the sand expansion transmitters is shown in Fig. 4. It consists of a special float with a vertical rod connection to a lever arm mounted above the filter and carrying a counterweight which can be easily adjusted so that the float will ride at the top of the expanded sand surface. The fulcrum of the lever arm is a shaft with knife-edge bearings, to which is fastened an arm controlling the movements of an air bellows diaphragm. The latter, in turn, is connected by air pressure to a bellows diaphragm in the recording gage. As the float moves, therefore, there is a corresponding movement of the gage mechanism. The sand expansion transmitters have a range of 9 in., which is ample to cover the expansion being used in washing the filters.

The operation of the sand expansion transmitters and gages is simple. Just before the backwash is turned on the filter, a switch starts the gage clock moving. The clock drives a circular chart at the rate of 1 rph. through an arc of 51.4 deg. and then cuts off. This allows the recording of seven washers on one chart.

The date of the wash is marked on the chart by the filter operator. The time that elapses for the pen to travel from one radial line to another is 2 minutes 8.6 seconds. The record on the chart gives the sand expansion and the exact length of the filter wash is

easily determined by scaling from the chart. The sand expansion devices with recording gages are proving valuable beyond anticipation in filter operation. A permanent record of the wash is made and the operator cannot wash a filter improperly without having it show on the chart.

The main difference between the filter rate controllers used in the South Dist. plant and those commonly used elsewhere is in the Venturi section (see Fig. 5). The Chicago specifications required the recovery cone to have an angle not greater than 5 deg., which is less than the angle generally used in rate controllers. The Venturi tubes are 10 ft. 3 in. long, with the recovery cone approximately 9 ft. long. The short 1½-ft. section of 20-in. pipe between the elbow and the Venturi tube in the photograph is found in only one of the 80 filters. This section of piping is 5.5–6.3 ft. long for the other 79 filters. Another variation not often found in rate controllers of large size is the use of one butterfly vane instead of two. The objective of this design was to produce a Venturi section that would offer the least disturbance to the even flow of the water through the controller. Surges in the flow of water through filters can be serious in improperly designed controllers.

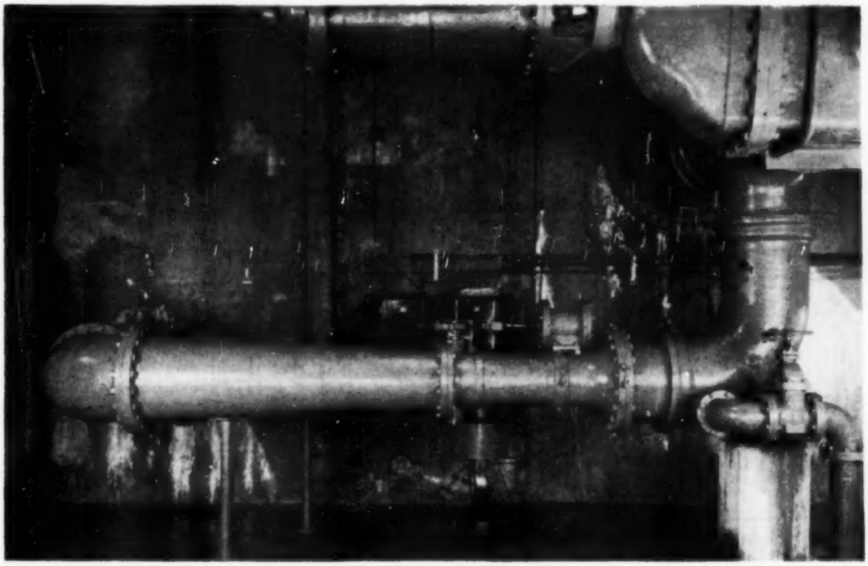

FIG. 5. Filter Rate Controller

The one-vane rate controller has functioned equally as well as the two-vane type. This change from the usual design not only lessened the cost of manufacture but also allowed the use of a circular recovery cone section. Ottherwise, it would have been necessary to go first from a circular section at the throat to a rectangular section at the butterfly vanes and then back to a circular section at the end of the tube, an arrangement typical of many

filter rate controllers now in use. It is the author's opinion that surging at high rates of flow has been decreased by this type of recovery cone.

The standard make of Builders-Providence diaphragm-actuated pilot valve with pendulum is used to regulate the rate of flow. Provision is made for constant-rate flow, or automatic variations of the flow in accordance with the level of the water in the clear-water reservoirs. An air-actuated bellows controls the automatic rate adjuster.

Three gage dials are mounted above each filter operating table, showing rate of flow, loss of head and sand expansion. To lessen the trouble so often encountered in transmitting the differential pressures to these gages, air pressure is used to actuate siphon bellows-diaphragms located in the gage cases that connect to the indicating hands and recorders.

Figure 6 shows the principle of the air transmitters used in the South District plant for transmitting the differential pressures produced in the filter rate controllers. Two copper tubes, one from the main section and the other from the throat of the Venturi tube, connect to a water diaphragm chamber. In turn, this diaphragm connects to a beam on a knife-edge bearing that operates an air bleeder valve. A mercury well, known as the balancing well, swings from the beam near the end and is connected by a flexible plastic tube to a stationary well set at a slightly lower level. The latter is connected to the air supply beyond a pressure-reducing valve.

The flow of water through the Venturi tube creates a differential pressure in the diaphragm chamber which causes the lever to move upward and close the air bleeder valve. Air pressure then is

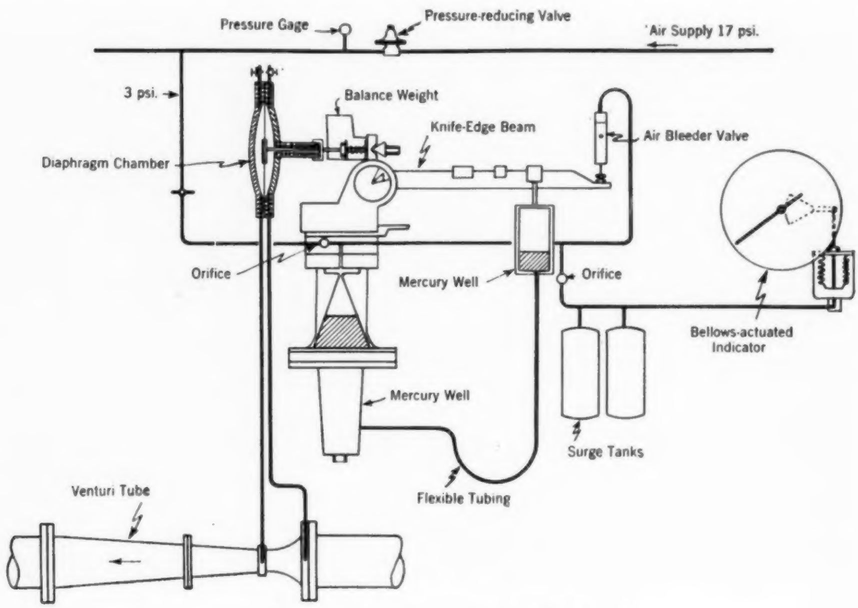

FIG. 6. Air Transmitter Principle

built up in the system, and a corresponding amount of mercury moves from the stationary to the balancing well. The lever arm then moves downward a small amount, increasing the rate of air escape, which in turn lowers the air pressure so that it balances the new forces on the lever arm. This air pressure is transmitted to a siphon diaphragm mounted in the gage case that actuates the indicator on the operating table. The stationary, transparent-plastic mercury well for the filter rate-of-flow measurement is bell-shaped so that the resultant air pressure is directly proportional to the rate.

The loss of head in the filter also is transmitted to the filter operating table by a similar device, except that the stationary well is cylindrical instead of bell-shaped. A submerged float at the sand surface operates the air transmitter of the sand expansion gage.

The summation on a single gage of the flows from a number of filters is easily accomplished by air-actuated meters. The flows from the twenty filters which face each of the four filter galleries in the South Dist. plant are summarized and indicated by a gage mounted on the master control table at the west end of each gallery. The principle of the air-operated summation of flow is illustrated in Fig. 7. The single pressure output from each filter, which is proportional to the rate of flow, is connected to a separate bellows-diaphragm at the summation unit. These diaphragms exert pressure on the outer end of the knife edge–mounted lever and cause the other end of the lever to exert a pressure on the single diaphragm proportional to the sum of the several pressures. The air pressure actuates the gage that indicates the summarized flow.

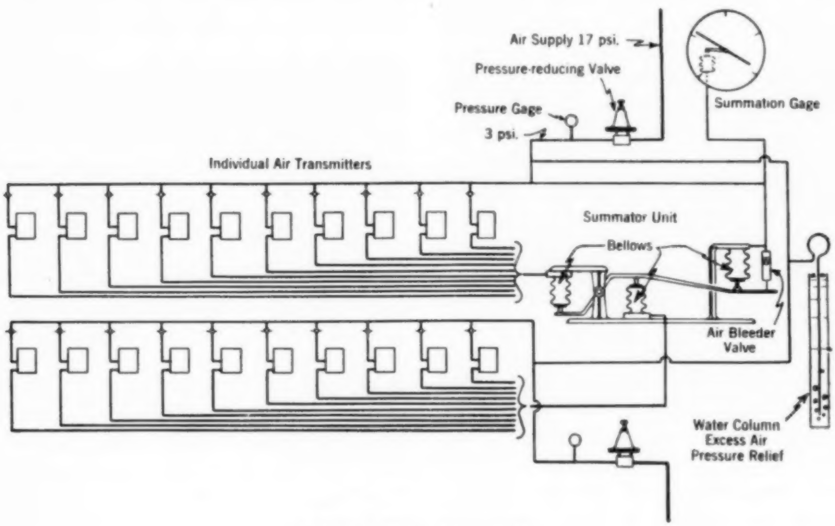

FIG. 7. Flow Summation

The single air pressure from each of the two 20-unit summators for Galleries 1 and 2 is connected to a duplex air bellows unit in such a manner that the resultant movement determines the length of the output signal of a Chrono-

flo * telemeter transmitter mounted in the same unit. A connected receiver-indicator mounted on one wall of the central operating gallery and a receiver-recorder in one of the master gages show the summated flow from the 40 filters. There is a duplicate installation for Galleries 3 and 4.

The filter operating tables are formed of steel cabinets with verde antique marble tops and terrazzo bases. Mounted on the parapet wall just back of the tables are a combined recording gage, a combined indicating gage for loss of head and rate of flow and a gage for recording the sand expansion. Both chart and dial gages are 10 in. in diameter and have fluorescent lights. A 48-hour chart is used for the combined loss-of-head and rate-of-flow recording unit. The sand expansion recorder also is 10 in. in diameter.

The transmission of the positions of the hydraulic valves in the filters from their location in the pipe gallery to indicators on the operating tables generally is troublesome. The prevailing practice is to use wire or chain cables with counterweights, but the cables do not have a long life. Moreover, there is often considerable difficulty with cables jumping off the pulleys, which are required at every change of direction of the cable. The contractor for the installation of the filter equipment offered flexible shafting to take the place of most of the length of each cable. A cable with a counterweight is fastened to the hydraulic cylinder. Movement of the valve stem turns a pulley that revolves the flexible shaft for the 30-in. and 42-in. valves. In the smaller valves a sprocket wheel and chain are revolved, connecting to a smaller sprocket fastened to the shaft. A 20-in. valve in moving from shut to full-open position will make ten revolutions of the shaft. Variable-size sprockets make the same number of revolutions of the shaft for the 12- and 20-in. valves. The flexible shafts connect to gearings on the operating table that move hand pointers through 100–115-deg. arcs.

A flexible shaft from the filter effluent valve leading to the operating table is shown just to the left of the center of Fig. 4. The counterweight for the flexible shaft of the filter backwash is shown in the upper part of the photograph to the left of center. The flexible shaft is made of piano wire and is housed in vinyl-covered, armored flexible tubing. Copper tubing was tried but did not permit the shaft to move freely.

Washing Filters

The procedure in washing a filter is to close the influent valve; allow the filter to continue in service until the water level is drained down to about 3 in. above the sand surface; close the effluent valve; open the waste valve; open the surface wash valve one-half; and start the backwash valve opening. The backwash valve opens slowly to prevent too rapid expansion of the filter material. Just before the water starts to overflow the wash water troughs, the surface wash valve is closed. The backwash valve is opened 10–12 in., the maximum rate of backwash being fixed by set vanes in the wash water meter which may be adjusted to any rate desired. The backwash rate is set at approximately 25 mgd. in the winter months and 30 mgd. in the summer. An effort is made to use a rate that will give a sand expansion of about 4 in. The setting is changed several times yearly as the water temperature varies.

* Product of Builders-Providence, Inc., Providence, R.I.

The filters are washed for about three minutes after the water starts to overflow into the troughs, and the backwash and waste valves are then closed. The filter influent valve is opened, first to about 5 in., then wide open after the water level is near that of the other filters. Opening the effluent valve places the filter back in service.

When the filters were put in service in 1947, it was necessary to operate some of them for a few months without using the surface wash. Figure 8 is a photograph of the mudballs at the surface of Filter No. 21 after seven weeks of such operation. There is a noteworthy contrast between Fig. 8 and Fig. 9, which shows Filter No. 14 after four months of operation with the surface wash. The volume of mudballs in the filters without surface washes increased to 5–15 per cent of the volume of the sand in the top 6 in. within a few weeks. This very high ratio indicates that the water has a considerable tendency to form mudballs and confirms previous experience at the experimental filtration plant.

FIG. 8. Filter Without Surface Wash

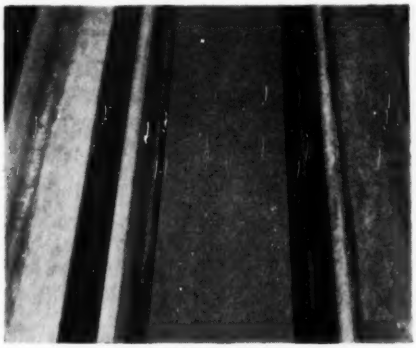

FIG. 9. Filter With Surface Wash

The surface of the sand shown in Fig. 9 is clean and smooth. Tests revealed none to only a trace of mudballs in filters where the surface wash was used regularly. After the completion of the installation of the surface wash piping, one regular filter wash of about four minutes would clear nearly all of the mudballs and none was visible after the second or third wash. The surface wash system, therefore, is more than adequate to meet the existing conditions.

High-Rate Filtration

At the beginning of operation in the new plant, ten of the filters in one gallery were set at a rate of 4 gpm. per square foot, or 8 mgd. for each filter. Since the chemical treatment of the water at times was not the same for all three settling basins, this influenced the results so that exact comparison was difficult.

On February 1, 1948, two filters in each of the four galleries were set to operate at 4 gpm. per square foot. On November 1, one high-rate filter in each gallery was set to operate at a 4.5-gpm. rate and four were continued at the 4-gpm. rate. An excellent quality of water was obtained at the 4.5-gpm. rate, and two filters, one in Gallery 1 and the other in Gallery 4, were

TABLE 2
Time in Service

Month	Time in Service—*per cent*							
	4-gpm. Rate							
	Filter No.							
1948	1	11	21	31	41	51	61	71
March	97.0	97.0	97.2	97.2	94.3	93.8	97.7	97.5
April	97.6	97.6	97.7	98.2	97.0	98.2	98.2	98.2
May	96.0	96.2	96.1	96.4	95.0	95.8	96.4	97.3
June	96.3	96.7	97.8	97.3	97.0	97.1	97.0	97.1
July	96.4	96.5	97.3	97.2	97.3	97.4	97.3	97.0
Aug.	98.6	98.6	98.6	98.6	98.3	97.8	97.7	97.8
Sept.	98.4	98.4	98.7	98.4	97.8	97.6	98.4	98.4
Oct.	98.2	97.4	97.0	97.1	97.2	97.1	98.4	97.1
Nov.	96.5		96.2		96.1		96.2	
Dec.			96.2		95.7		95.5	
1949								
Jan.	98.0		98.0		97.4		97.6	
Feb.	98.0				97.6		98.3	
Avg.	97.4	97.3	97.3	97.5	96.7	96.8	97.4	97.4

Month	4.5-gpm. Rate				5-gpm. Rate	
	Filter No.					
1948	11	31	51	71	10	80
Nov.	95.5	96.0	95.8	95.8		
Dec.		95.8	95.0	94.9	93.2	93.2
1949						
Jan.	97.2	95.8	97.4	97.2	95.7	95.4
Feb.	97.4		97.6	97.1	96.3	96.3
Avg.	96.7	96.5	96.5	96.2	95.1	95.0

set to operate at a 5-gpm. rate, or 10 mgd. each.

The operation of these high-rate filters was the same as for the others in the plant, except that the operators were instructed to wash each filter before there was dropping off in rate due to clogging.

Hydraulic conditions in the filters are none too good for high-rate operation. To illustrate, on the units operated at a 5-gpm. rate, an increase in loss of head of only about 3.2 ft. is available with filtered-water reservoirs full. Evidence indicates considerable friction loss in the filter effluent piping and rate controller. The friction loss through the sand layer at the 5-gpm. rate, according to measurements made on one filter, was 1.83 ft. at 33°F. and 1.32 ft.

at 44°. At a 2-gpm. rate the loss was 0.67 and 0.54 ft., respectively.

The loss of head with a clean filter just started in service, at a 5-gpm. rate and a water temperature of 33°, occurs approximately as follows:

Place	Loss—*ft.*
Influent piping	0.21
Sand	1.83
Gravel and underdrains	1.00
Effluent piping and rate controller	3.8
Total, exclusive of clogging	6.84

The data on filters operated at high rates are summarized in Tables 2 and 3. Table 2 gives the percentage of time in which each filter was maintained in service. The only time out of service was for washing. The average percentage of time in service for eight filters operated at a 4-gpm. rate was 97.2; for four filters at a 4.5-gpm. rate, 96.5; and for two filters at a 5-gpm. rate, 95.0. These percentages are slightly higher than would be realized in routine plant operation but could be approached closely if there was an emergency condition to justify securing the maximum filtration rate possible.

The data in Table 3 on lengths of filter runs indicate a marked dropping off as the rate is increased. (At the 4-gpm. rate, the average length of run was 15.4 hours; at 4.5 gpm., 10.4 hours; and at 5 gpm., 8.1 hours.) This condition was caused by the hydraulics of the filter reducing the available head; that is, for the filters operated at the 5-gpm. rate, the initial loss of head as shown by the gage on the operating table was 3.8 ft., and the loss at which the rate of flow began to decrease was 7 ft., when the clear-water reservoirs were full, leaving only a 3.2-ft. increase over the initial loss.

The table does not give the lengths of runs for filters operated at a 2-gpm. rate, because most of the slow-rate filters were on automatic rate control and varied widely during the day, often operating at rates less than 2 gpm. Filters operated at low rates ran longer than those at higher rates, but the difference was not proportional to the rate. The average length of run for all filters in December 1948 was 13.1 hours.

The loss of head through the sand cannot be reduced by design, except through the use of coarser sand, but other losses can be lessened. The initial loss through the sand in the summer, when the high rates are most likely to be used, will be less than for the winter months. No difficulty should be experienced in designing filters with a head loss of 6–7 ft. over the initial loss. This should give lengths of runs approximately twice those now obtained at the 5-gpm. rate, or approximately fifteen hours under the conditions that prevailed in December and January. At one time plans called for filter effluent piping and rate controllers of 24-in. diameter instead of the 20-in. piping now installed.

Turbidity

Armed with sensitive turbidity detection devices, comparisons of filter efficiency should be accurate. The instruments used consist of: [1] floc detectors, accurate to 1.0 volume of floc; [2] Baylis turbidimeters, accurate to a turbidity of 0.1; [3] submerged light in the filtered-water reservoir, accurate to a turbidity of less than 0.1; and [4] cotton plug filters, accurate to a floc volume of less than 0.1. A floc turbidity of 1.0 is equivalent to a floc volume of approximately 15. The cotton plug filters were placed in service on most of the filters in November 1948.

No increase in the filtration rate should be made if it lowers the bacteriological efficiency of the filters or causes coagulated matter to pass through in

TABLE 3

Length of Filter Run

Month	Length of Run—hr.							
	4-gpm. Rate							
1948	Filter No.							
	1	11	21	31	41	51	61	71
March	15.1	15.1	12.1	12.7	22.9	19.1	18.2	16.2
April	18.5	17.6	16.4	16.8	18.1	16.0	17.6	18.6
May	12.5	10.8	11.7	11.7	14.9	10.5	12.7	13.7
June	14.3	11.4	14.1	13.8	14.7	12.5	13.0	12.3
July	14.5	13.5	13.5	14.8	15.5	14.3	13.7	12.5
Aug.	21.5	21.6	20.9	20.4	21.5	20.8	19.3	19.2
Sept.	21.5	19.7	20.9	20.9	22.2	20.9	21.8	20.3
Oct.	15.6	14.7	12.7	12.7	13.0	12.9	11.6	11.0
Nov.	10.6		10.1		8.8		9.1	
Dec.			8.9		8.8		8.5	
1949								
Jan.	16.1		16.3		12.9		14.0	
Feb.	19.6				14.7		13.3	
Avg.	16.3	15.5	14.4	15.5	15.7	15.9	14.4	15.5

Month	4.5-gpm. Rate				5-gpm. Rate	
1948	Filter No.					
	11	31	51	71	10	80
Nov.	7.9	9.2	8.0	8.0		
Dec.		8.3	7.8	7.4	6.8	5.7
1949						
Jan.	12.3	13.9	12.3	10.6	9.5	8.1
Feb.	13.9	12.7	12.3	10.5	10.0	8.8
Avg.	11.4	11.0	10.1	9.1	8.8	7.5

objectionable quantities. The bacteria generally are killed by chlorination before the water is filtered, so that there is nothing or almost nothing to expect of the filters in this regard. The only measure that may be applied is the turbidity of the filter effluent, and the standard set by the South Dist. Filtration Plant is 0.1.

Table 4 shows the turbidity and floc volume measurements on filters operated at 5-gpm. rates, which may be compared with the data in Table 1 on a 100-sq.ft. filter in the experimental filtration plant in January 1930. The conditions then existing were caused by the extreme weakness of the coagulation. Significantly, so much coagu-

TABLE 4

Floc Volume and Turbidity—High-Rate Filters

Date	Filter No. 10			Filter No. 80		
	Head Loss *ft.*	Floc Volume	Turbidity	Head Loss *ft.*	Floc Volume	Turbidity
1948						
Dec.						
13		0	0.0		0	0.0
14	3.9	trace	0.0	4.7	0	0.0
15	5.7	trace	0.0	7.4	trace	0.0
16	6.5	0	0.0	7.2	0	0.0
17	6.0	0	0.0	5.9	trace	0.0
18				4.9	trace	0.0
20				6.1	trace	0.0
21				4.7	0	0.0
22				6.5	trace	0.0
23				4.1	0	0.0
24				4.2	trace	0.0
28				8.2	0	0.0
29					0	0.0
30				4.7	0	0.0
31				5.9	0	0.0
	Out for painting piping					
1949						
Jan.						
4				5.0	0	0.0
5				6.0	trace	0.0
6				4.1	0	0.0
7				7.5	0	0.0
8				6.7	0	0.0
11				5.1	0	0.0
12				6.8	0	0.0
13				4.7	0	0.0
14	7.2	0	0.0	4.5	0	0.0
15	7.3	0	0.0	5.2	0	0.0
18	7.2	0	0.0	5.7	0	0.0
19	Out of service			7.3	0	0.0
20	6.8	0	0.0	5.6	0	0.0
21	5.1	0	0.0	7.5	0	0.0
22	4.6	0	0.0	5.9	trace	0.0
25	6.5	0	0.0	6.7	0	0.0
26	5.5	0	0.0	6.4	0	0.0
27	Out of service			6.5	0	0.0
28	4.1	0	0.0	7.6	0	0.0
29	4.7	0	0.0	6.7	0	0.0
31		0	0.0	5.0	0	0.0
Feb.						
1	4.5	0	0.0	4.4	trace	0.0
2	5.2	0	0.0	5.9	0	0.0
3	4.3	0	0.0	5.3	0	0.0
4		0	0.0	0.2	0	0.0
5	5.2	trace	0.0	7.3	0	0.0
8	7.1	trace	0.0	5.8	trace	0.0
9	4.7	0	0.0	5.0	0	0.0
10	5.8	0	0.0	4.5	0	0.0
11	4.3	0	0.0	6.7	trace	0.0
12	5.0	0	0.1	5.0	trace	0.1
14	5.7	0	trace	6.8	0	0.0
15	6.2	0	0.0	7.2	0	trace
16	4.5	0	0.0	6.3	0	0.0
17	4.6	0	trace	4.3	0	0.0
18	4.1	0	0.1	6.5	0	trace
19	3.5	0	0.0	4.5	trace	0.0
21	3.8	0	0.0	4.6	0	0.0
22	4.5	0	0.0	4.8	0	0.0
23	4.7	0	0.0	6.7	0	0.0
24	5.4	0	0.0	6.0	0	0.0
25	6.5	0	0.0	7.5	0	0.1
26	5.7	0	0.0	4.5	0	0.0
28	2.0	0	0.0	6.7	0	0.0
Mar.						
1	2.0	0	0.0	4.5	trace	0.0
3	6.0	0	0.0	4.5	0	0.0
4	5.3	0	0.0	8.0	0	0.0
5	3.7	0	0.0	7.3	0	0.0
7	7.1	0	0.0	5.3	trace	0.1
8	5.4	0	0.0	5.1	0	0.0
9	4.4	0	0.0	5.3	trace	trace
10	3.1	0	0.0	4.5	0	0.0
11	2.0	0	0.0	7.5	0	0.0
12	7.1	0	0.0	6.4	0	0.0
14	2.0	0	0.0	6.1	0	0.0
15	7.6	0	0.0	6.8	trace	0.1
16	6.8	0	0.0	7.6	trace	trace
17	4.6	trace	0.1	7.5	trace	0.1
18	3.3	5	0.2	4.4	1.0	0.1
19	2.4	0	0.0	1.7	0	0.0
21	6.6	0	0.0			
22	6.4	0	0.0			
23	5.4	0	0.0			
24	3.8	0	0.0			
25	7.7	0	0.0	Out for painting piping		
26	6.6	0	0.0			
28	7.6	0	0.0			
29	4.2	0	0.0			
30	7.3	0	0.0			
31	5.3	0	0.0			

lated matter passed the experimental filters after a few hours of operation that the water would have been classed as undesirable for use. Five other filters of 10-sq.ft. size were in operation at the same time and gave equally poor results. Silicate for strengthening coagulation had not yet been developed.

Acid-treated sodium silicate is such a powerful coagulant-strengthening agent that raw water of almost any quality may be coagulated and filtered through coarse sand at high rates without danger of coagulated material passing the filters. As used here, the term "coarse sand" means sand of 0.65–0.90-mm. effective size.

By far the most sensitive testing device for coagulated material passing filters is the cotton plug filter. Figure 10 is a sketch of the filter and float valve for regulating the flow, which is maintained at approximately 100 ml. per minute. The method is based on the effectiveness of absorbent cotton in filtering out any coagulated material in the water. Every particle of such material in the water passing through the filter is retained in the cotton. The material is allowed to accumulate until visual observation shows that there is enough to be weighed after burning to ash in a muffle furnace. All filters pass at least a minute amount of coagulated material. Several days to two weeks generally are required to accumulate enough material in the cotton to make an accurate weighing. The cotton plug filters run continuously while the plant filters are in operation and serve as an efficient check.

Table 5 gives a summary of cotton plug filter tests during December and January. Although no difference in the effluent water at various rates of filtration could be detected with the most sensitive turbidity testing instrument, the cotton plug results showed a slight difference in favor of the filters operated at slow rates. In comparing the automatic rate control filters with the others, it is well to keep in mind that their average rate of filtration was considerably less than 2 gpm. Sufficient data are not available as yet to state the amount of coagulated material that should not be exceeded.

The turbidities shown in Table 4 generally were colloidal and not floc turbidity. During the period March 16–20, 1949, higher turbidities in the raw water and a greater tendency to produce weak coagulation caused some coagulated material to pass the high-rate filters. The amount of sodium silicate being used was low (only 10 per cent of the amount of aluminum sulfate) and was not enough to strengthen the coagulation adequately. The dosage was purposely left low for a few days to see what would happen. An increase in silicate dosage gave the necessary strength to avoid the passage of an objectionable quantity of coagulated material, as is shown in Table 5 for the period from March 25 to April 15.

The strongest coagulation is produced when the sodium silicate added

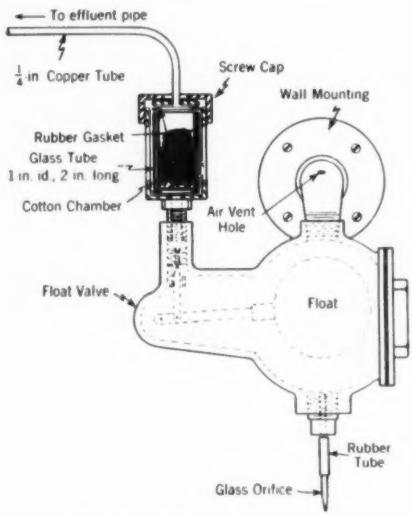

Fig. 10. Cotton Plug Filter

(as SiO_2) is about 40 per cent of the aluminum sulfate. The amount being added before March 16 was 7–10 per cent. On March 18, it was 11.7 and on March 20, 12.3 per cent. The dosage therefore was quite low and more strengthening of the coagulation could have been produced. Table 5 shows the effect of adding more silicate after March 25.

Value of High-Rate Filtration

Cost is the main consideration in adopting high-rate filtration but is not

the principal reason for using acid-treated sodium silicate to strengthen coagulation in the South Dist. plant. The silicate treatment produces a high-quality water all the time, which would otherwise not be possible occasionally. In many filtration plants throughout the country, a need exists for the use of a coagulation-strengthening agent during periods of weak coagulation, even though the filtration rate does not exceed 2 gpm. If by resorting to the silicate treatment at a 3-gpm. filtration rate, water is produced of a quality superior to that at the 2-gpm. rate without its use, it seems reasonable to employ the higher rate. Certainly no one will try to defend the quality of water recorded in Table 1 as being satisfactory.

The silicate treatment not only answers the need for better coagulation, but it helps coagulating agents so effectively by producing tougher coagulation that its power should be taken advantage of in lessening plant costs. Generally, the cost of the silicate and acid is equaled by the reduction in the amount of coagulant required, though this will not be true for all waters.

Most filtration plants are so designed that rates of filtration considerably above 2 gpm. cannot be used because of the excessive loss of head. Engineers planning new plants should at least design the filters for higher rates than heretofore, even though the use of such rates is not immediately contemplated. If high rates are to be employed without using the silicate aid to coagulation, filtration plant operators should try one or two filters at the high rate to see what quality of water is produced.

TABLE 5

Ash From Cotton Plug Filters

Period	Filtration Rate				
1948–49	10 mgd.	9 mgd.	8 mgd.	6 mgd.	Automatic and 4 mgd.
	Ash—*ppm.*				
Dec. 1–15	0.027	0.031	0.027		0.021
Dec. 15–Jan. 15	0.058	0.034	0.034	0.032	0.031
Jan. 15–Jan. 27	0.060	0.025	0.037	0.041	0.029
Jan. 27–Feb. 3	0.048	0.027	0.028	0.030	0.022
Feb. 3–Feb. 11	0.044	0.042	0.033	0.030	0.017
Feb. 11–Feb. 18	0.030	0.025	0.025	0.021	0.015
Feb. 18–Feb. 25	0.036	0.038	0.027	0.027	0.017
Feb. 25–Mar. 4	0.041	0.044	0.033	0.038	0.021
Mar. 4–Mar. 11	0.062	0.051	0.055	0.041	0.022
Mar. 11–Mar. 18	0.083	0.074	0.072	0.064	0.022
Mar. 18–Mar. 25	0.074	0.051	0.055	0.045	0.020
Mar. 25–Apr. 1	0.022	0.024	0.026	0.023	0.014
Apr. 1–Apr. 8	0.023	0.025	0.031	0.045	0.021
Apr. 8–Apr. 15	0.036	0.043	0.031	0.034	0.025
Avg.	0.046	0.038	0.037	0.036	0.021

Design and Operational Problems of Small Water Plants

By Ivan M. Glace and Martin E. Flentje

A paper presented on May 30, 1949, at the Annual Conference, Chicago, by Ivan M. Glace, Cons. Engr., Harrisburg, Pa., and Martin E. Flentje, Research Engr., Water Works Service Co., Inc., New York.

IN reaching a decision to write this paper the authors had first to decide whether, in their opinion, there were actually problems affecting water quality connected with the operation and design of small water works; and then, if such problems existed, what they consisted of and what might be done to solve them. After considerable thought, argument and checking through past experiences, the authors have come to this conclusion: there is no small-plant operation problem *per se;* that is, there is no major problem —at least as regards water quality— that is due to smallness of size alone. Alum coagulates turbidity in small amounts of water as well as in large; settling takes place in a small, properly designed basin as well as in a large one; good filtration can be obtained through a 75-sq.ft. filter as well as through one with 1,400 sq.ft. of surface area; bacteria succumb to chlorine when this chemical is properly applied, be the quantity treated large or small; and corrosion reactions proceed independently of water volume.

Nevertheless, after analysis of their considerable experience with "small" plants (to be defined later), the authors feel that there is a need to point out several factors which, apart from size, do affect small plant operation and design and consequently may have an effect on public health. The importance of these items seems to warrant consideration and discussion. It should be emphasized, however, that this paper covers water quality problems only, neglecting small-plant management, distribution, public relations and similar matters. In this connection, such terms as "technician," "supervisor" or "skilled" do not necessarily imply a college-trained man. (Obviously, proper college training will provide the basic technical knowledge and the background that may warrant these titles, but the same knowledge and background can be obtained outside of college walls, although, of course, only with great effort and against considerable odds.)

The term "small," as used herein, generally designates a water works with a capacity below approximately 1 mgd. There are, however, plants with capacities considerably above this figure which the authors would still consider in the "small-plant" classification because of the manner of operation— that is, by operators unlearned and untrained in the technical aspects of maintaining water quality. Conversely, there are many plants with a capacity of less than 1 mgd. which, through skillful operation, cannot be called "small" except in the matter of size alone.

The above definition indicates somewhat the confusion that can easily enter into a discussion of this kind. The authors have used the adjective "small" to indicate both size and quality of operation. No apology is offered, however; in the authors' opinion, the entrustment of such an important public duty as supervision of water quality to unskilled hands *is* "small." For the sake of clarity, the adjective "small" will hereafter refer to size only and will be applied to plants with an output below 1 mgd., but it is insisted that no such arbitrary line of demarcation actually exists.

In comparison with larger plants, a survey of water works sending less than 1 mgd. to the distribution system will generally, it is believed, show them to have: [1] a more complex system of water supply and a greater diversity in type of water source, [2] less specialization of activities by the operating personnel, [3] treatment plants often inadequate to meet the problems involved and [4] high unit costs.

Diversity of Sources

The smaller community will often obtain its public water supply from more than one source. Sometimes these sources will be quite widely separated, and often they will differ markedly in quality and chemical character. To mention a few examples: a Pennsylvania plant has two sources of supply—the principal one is a mountain stream, soft, clear after impounding and quite acceptable after pH correction; the second, auxiliary source is a large river, the water from which is filtered but is looked upon with considerable disfavor by the consumers because it is generally known that the river carries the sewage of upstream cities. The filtered water is also considerably harder, although it meets every standard of bacteriological safety. This situation introduces many difficulties: for example, the fact that men were not continuously employed at the filtration plant made proper operation troublesome, and dependable new men were difficult to find. Only an expensive plan of distribution system segregation to allow the use of the river water by a single large industry, with the upland water going to the rest of the consumers, has proved satisfactory. In another small plant, the primary, very acceptable, soft, clear spring supply must be augmented each summer and fall with harder water from wells containing considerable dissolved iron. These illustrations can readily be multiplied many times over.

Originally the water supply of such communities consisted of a single well, a spring or a small stream. As the community grew a second and third well were put down nearby, the spring supply was extended or the stream water was impounded in a reservoir. Further growth led to increased development, until it became apparent that no additional water was available at the original location. The second supply then came into being and sometimes a third. Usually these auxiliary supplies were quite distant from the original one, and the water was often of an entirely different character. Today the superintendent of one of these systems is faced with the care and operation of several sources; when his principal supply begins to fail, he must sometimes resort to a water source that imposes a considerably more complex treatment problem and this must be accomplished with men hired for or assigned to this job for only a portion of the year. The water delivered to the system from the

secondary source may be inferior in quality and character from a chemical and physical standpoint because of a lack of adequate facilities—facilities denied the operator because their provision does not seem economically sound for a part-time supply. The operator must therefore live with these conditions and do the best he can.

The best way to meet this situation is, obviously, to have good operators. To get such men, communities and small water companies must expect to pay good salaries, commensurate with the degree of operating skill involved. In addition, reasonable tenure of office must be assured. Furthermore, the community would find it economical to provide the operator with consulting and technical advice to make the most of the existing facilities. The town should not expect its superintendent to be an expert engineer, chemist, construction man and public relations expert all in one, nor should he try to be.

Although it is true that the state health departments, to a certain degree, supply technical advice and information, the authors do not feel that a water department can depend solely upon this source. The health department is primarily a "watch-dog" or "police" agency (the terms seem harsh and inadequate but are used for want of better ones) and, in most states, has neither the time nor the men to provide consulting facilities. Moreover, such agencies can do more by independent checking, by providing training facilities, and by setting up opportunities for gaining knowledge. There is no need to mention the genuine good these departments have done and are constantly doing for the public health in their efforts to improve operations.

It is a known fact that a considerable number of small plants have been operating without even a small measure of technical control during their entire existence. Certain supplies from surface streams are still being used without even the benefits and safeguards provided by chlorination; and some ground water supplies are used which have never had a chemical analysis. In such systems it is not uncommon to find pipelines deteriorating markedly and "red water" used with no attempt at control, with tastes and odors eliminated simply by suffering until the cause has disappeared. The problem of cross connections to the public system is altogether unconsidered. In some states, the only bacteriological analyses are those made by the state itself, which, it is known, may occur at such infrequent intervals as to be measured by years rather than days.

The excellent record of the water works profession in reducing waterborne diseases, on the whole, is a matter for congratulation but the authors feel that weak spots still exist in the lines of defense, and that they are more likely to be found in the smaller than in the larger plants.

Need for Specialists

It is axiomatic that less specialization in jobs is to be found in the small water purification plant than in the large one. The employment of a full-time chemist and bacteriologist to run the few daily tests actually required in a small plant hardly seems warranted unless there is present some very unusual purification problem. Similarly, in a plant employing four or fewer men, one of these could hardly find sufficient work to do if he devoted all of his time to maintenance. The small-plant opera-

tor must do all of these things and actually operate the plant also. In other words, he must be almost a "jack of all trades." Belying the old adage, experience shows that many of these operators are not only able to do the various things required of them, but are indeed "masters" too! Their ingenuity, resourcefulness and dependability cannot be extolled too highly. On the other hand, however, there are, to the discredit of the profession, too many operators of small works who do not fall into the "master" classification, especially in maintaining control over water quality.

The economic impossibility of having specialists is certainly a disadvantage at times. The preparation of water for human and industrial consumption is a highly technical undertaking and there are occasions when only specialized training and experience can solve the problems that arise. The authors have reviewed the instances occurring in the past few years in which, to their knowledge, smaller water companies have found themselves in trouble and in need of technical advice. It may be rather surprising to many operators that algal growths have been one source for a number of these requests and corrosion problems accounted for many more. If it seems hard to believe that an algae problem, or a little red water, would warrant calling in a chemist, biologist or sanitary engineer, a bit of thought may convince the reader. Many operators apply a preventive dose of copper sulfate in the early spring, yet, unless there are growths present, this procedure can only be wasteful because the chemical does not kill algae as spores. Other plants apply copper sulfate monthly or bimonthly, yet algae grow so prolifically when food and temperature conditions are favorable that a "bloom" can become troublesome in three to six days or develop in between "shots." An application can be completely effective only at that point of the growth curve where the organism causing the bloom begins to become weakened; and the proper dose for the particular organism involved must be applied. Counting and identification of the thousands of forms are difficult without training and knowledge of the technique of microscopic examination. In the matter of corrosion, there is confusion between the terms "deposition" and "corrosion," considerable lack of comprehension of the chemical and physical factors involved and a misconception about the results actually to be obtained through chemical treatment (for example, operators speak of making a water "noncorrosive," as though this were practically attainable in a public water supply).

The point the authors wish to make is that somehow the general public and certain operators and owners must be made to realize that water treatment often becomes highly technical in nature. Then, through some means, the community, having employed competent operators and provided proper compensation, should not hesitate to go further and see to it that technical help is employed *if and when needed.* If the state health department can furnish the necessary help, so much the better, but the operator should know when and where to go for assistance and should be free to make such a request.

Inadequate Plants and Design

In the design of small plants, the problem of economics again enters the situation. The fact that the same problems of treatment confront both the

large and small plants means that both must be complete in facilities and equipment and this results in high unit costs for the latter. The total cost of design, although considerable, may still not be sufficient to attract the larger designing and consulting firms. The design of a small purification plant should be entrusted only to good, experienced engineers. In a large-plant project, money is available for preliminary study and investigation, which is seldom true for the small plant. In a large plant also, a more complete and probably somewhat more reliable record of water character and conditions will be available, a fact that must be taken into consideration and possibly compensated for in "overdesign" and in providing greater factors of safety for the small plant; that is, providing for a degree of completeness of treatment facilities in the small plant that will allow it to meet unknown conditions not revealed by the records. In the authors' opinion, any added cost of design due to safety measures and the use of reliable design engineers is well justified for the small plant.

Designers sometimes fail to appreciate the problems that confront the operators of small plants. Well installations and well houses almost invariably have no provision or space for treatment facilities, yet few well supplies remain in service without the development of a condition that requires treatment at some time or other. Equipment to feed accurately the low quantities of chemical required in a small plant is difficult to obtain. For alum, solution feeding seems to offer advantages over most dry feeders, in the small plant. Unfiltered impounded gravity supplies seldom have any provision for chemical treatment other than chlorination, but when a new reservoir is being designed and constructed, it would add little to the cost and greatly facilitate later treatment if a forebay or treatment area were laid out between the reservoir and the distribution system intake. In a gravity system, consideration must be given to proportional chemical feeding, which again serves to point up the need for intelligent operators, because such equipment is somewhat complicated. The intent of this paragraph is to emphasize the desirability of installing, between the source of supply—whether from ground or surface—and the distribution system, some basin or reservoir or tank to smooth out unequal flows and to permit accessibility for treatment.

On the question of automatic plants, the authors find themselves in some disagreement. Glace feels that a safe, completely automatic water purification plant is impossible, while Flentje believes such a plant is entirely possible if it can be justified from an economic standpoint. There is no doubt that a plant of this type, properly safeguarded, would be expensive. The authors agree, however, that better operation of both large and small plants awaits the development of equipment that will "measure" treatment conditions at various plant stages and signal, record and perhaps even correct the treatment. Nearly everyone will admit that much of the coagulation process, for example, is controlled by eye, the appearance of the floc in the mixing basin being the first plant control of the coagulant dosage exercised. This procedure, quite likely, means a high percentage of overtreatment with its attendant evils; an electronic device measuring some physical or chemical characteristic of the coagulated water that changes with the

degree of coagulation could not help but be of service in this situation. Such a device should also not be too difficult to develop and, if successful, could probably be used to regulate chemical application as well and thereby relieve men for the many other duties around the plant.

A detailed study of the Eliassen-Cummings (1) summary of waterborne outbreaks in the United States suggests a definite correlation between such epidemics and small-plant operation and design. Typhoid incidence was used for this analysis rather than the more general gastro-enteritis figures. Although the typhoid data provide a smaller yardstick, they are much more precise and reliable because of the uniformity of reporting by the states.

Apparently only one major waterborne typhoid epidemic among public supplies has occurred in the United States since 1938, involving 1,359 cases. The average has been only 14 cases per epidemic. Only two of a total of 99 outbreaks have been credited to the failure of purification processes; the remainder have been largely due to physical defects in springs and wells and to the use of untreated surface and ground water supplies, so-called "natural water."

The small size of the populations involved in most of these epidemics, and the absence of purification, are very significant in a study and discussion of small-plant operation. Explosive typhoid epidemics no longer occur in large plants because of the many safeguards provided against the passage of contaminated water into distribution systems. Greater reduction in the number of such explosive epidemics apparently can be obtained only by more effective control of the small, old, supposedly "safe supplies, many of which have 'safe' records of a century of operation."

High Unit Costs

The labor costs of producing 1 mil.-gal. of water in a complete filter plant will be relatively high if operated on a 24-hour basis. If less than 1 mgd. is sent out, the costs will be correspondingly higher, because a minimum of one operator must be on duty at all times. If the system contains sufficient storage to keep the plant operation below three shifts, some savings will result. This feature of the small plant does not seem possible of elimination unless some automatic methods prove successful in the future or unless, through increased capital costs for larger plants and storage, all water can be produced in a short work period. A community faced with these facts must realize that water under small-plant conditions will cost somewhat more per million gallons than in a large plant. Even so, it will still be the least expensive of utility services. Attempts to economize should not be made at the expense of the water works operators' salaries.

Conclusions

The authors have reached several conclusions on the basic facts which distinguish the small plant from the large plant, especially in the field of water purification:

1. There is a very great diversity in the number of types and kinds of raw water sources, and in the general physical makeup of small supplies, as compared with larger plants.

2. The quality of the engineering skill, as well as the total amount of engineering services, used in the design

of small plants is generally in proportion to the size of the works.

3. The quality of operating skill is generally, but not always, in direct proportion to the size of the works.

4. Provision for the control of water quality, other than for bacterial safeguards, is generally unconsidered in the design and installation of small water works, except in those with filters.

5. The lack of supervision of the operation of small works by technically trained personnel is notable and is one of the outstanding weaknesses in the operation of such plants; it indicates the failure of many communities to accept the recommendation of the U.S. Public Health Service (2) that: "Every water plant engaged in purifying water for domestic use shall be under the charge of a technically trained supervisor."

The extreme importance of this provision needs strong emphasis. It is a known fact that many small supplies do not meet this requirement. The state health departments should make it a stipulation of all permits issued on public water supplies and should, moreover, by licensing or otherwise, allow only Grade *A* technicians to undertake such supervision. The word "purifying" in the above quotation should be changed to "serving."

6. Water service is now and always has been sold at unreasonably low rates. Adequate revenues should be secured to provide trained technical assistance for technical problems.

7. Small plants should be designed, as far as is possible, with the principal consideration not for the economics of the design, but for foolproof operation.

8. The smaller the water works, the more rigidly should the standards of modern practice be exercised in design, as compensation for the probable unskilled type of operation.

9. The licensing of operators is not the complete answer to better small-plant operation; rather the problem is one of economics. When, and if, water revenues are adequate, capable personnel will be engaged for proper operation.

10. The deterioration of pipelines to the point of complete failure has become a serious economic problem in some plants and is the result of lack of proper understanding or use of the fundamentals of corrosion control.

11. Small-plant operation merits the attention of large-plant operators, and means should be found for summarizing the operating experiences of small plants.

12. Many small plants are being operated in excellent fashion, and with excellent results.

13. Further discussion of the problem of small-plant operation should be continued vigorously on the sectional level by the Association.

14. Control by the states over the safety requirements of public water supplies might well be extended to cover other important phases of the quality of public supplies, with such control apparently best vested in state health departments in order to avoid duplication of effort and overlapping of duties by other state departments.

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Discussion

E. R. Dougherty

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Small water systems in cities with a population near 10,000 serve a greater proportion of the country's population than is often realized. As the authors point out, a small plant of less than 1-mgd. capacity can, with proper design and competent personnel, be operated at least as efficiently as a 10- or 25-mgd. plant. Regardless of size, the goal to be reached is the same: a raw material is taken and refined into a suitable finished product, free from bacteria, palatable and, it is hoped, chemically balanced. The writer can say without reservation, however, that, in the systems which he has supervised during the past eighteen years (ranging in capacity from 0.25 to 8 mgd.), the operation and management were accomplished with much greater ease in the larger plants than in the smaller ones. Larger plants are able to employ a specialist in each category—management, chemistry, bacteriology, accounting and so on. The writer found it easier to supervise the 8-mgd. softening plant of the General Motors Corp. at Indianapolis, Ind.—including treatment units for boiler water, air-conditioning water and de-ionized water for silver plating—than to run, without specialists, the 0.25-mgd. plant he is now operating.

The small plant has about the same problems as the larger one, generally speaking, but they are usually accentuated by the lack of equipment. In the smaller plants, the superintendent is the "country doctor," treating all of its ills himself, to a great extent. It is only natural that the operator of a small plant feels that he is carrying a greater burden of responsibility than any individual specialist. It is fortunate that there are a great number of operators who are well qualified, having received their knowledge inside or outside college walls. The small-plant superintendent or operator, like the supervisor of a large metropolitan system, has the responsibility for public health as well as for protecting a large capital investment. In small cities the capital investment per capita is much greater than in the large metropolitian areas.

The authors state that small plants should be designed, as far as possible, with regard not primarily for economy, but for foolproof operation. Many superintendents would probably settle for a plant which is designed so that it could be operated efficiently. The writer has had occasion to visit a number of plants in six states in the Middle West. In this area there are a great many small plants designed with inadequate mixing facilities, insufficient detention periods or high velocities in the settling basins. One of these conditions, if not all, is usually present. The answer to the problem is good design and competent operators rather than foolproof plants.

Need for Capable Men

It is also stated that the smaller the water works, the more rigidly should the standards of modern practice be exercised in design as compensation for the probable lack of skill in operation. With this statement the writer does not fully agree. An investment of several hundred thousand dollars in a water

water works system definitely calls for a competent manager. This man should know water purification and operation or he is in the wrong field. The choice of a competent supervisor would eliminate the necessity for foolproof operation or automatic plants.

The writer is forced to disagree with the authors' contention that "licensing of operators is not the complete answer to better small-plant operation; rather the problem is one of economics. When, and if, water revenues are adequate, capable personnel will be engaged for proper operation." The writer's experience goes to show that licensing of operators *is* the answer.

Bowling Green Experience

In March 1948, the writer was asked by the Board of Public Works of his home town, Bowling Green, Mo. (population 2,200), to consider the position of superintendent of water and sanitation. Since the writer did not particularly desire the post, he asked for a 75 per cent increase in salary, or a bonus equal to the amount of money which he would save the city over a period of a year. Needless to say, the salary increase was readily granted by the board after the writer had turned in a report describing the condition of the water filtration plant and explaining why the city was losing money.

Practically no maintenance work had been done for the past five years. The gravel in one filter had been blown to the top in several areas. The chlorinating apparatus was not operating properly, and the high- and low-service pumps were not in good condition. The raw-water hardness, which ranges consistently from 100 to 130 ppm., had been increased in operation to 297 ppm. No analysis or tests had been performed; chlorine residuals were probably checked weekly, but there were no records to speak of. The finished water was so unstable chemically that the capacity of the 2-in. service line, which was later replaced, had been reduced to less than the capacity of a ½-in. pipe. The condition of the mains had not been inspected, but the flow from the fire hydrants showed it to have been greatly reduced. The impounded raw-water supply had been undertreated with copper sulfate for algae growth, and neither superchlorination nor free residual chlorination had been applied at the filtration plant, resulting in a large number of complaints. The pumpage was 70 per cent higher than the recorded consumption, and a great amount of this water was passing through stopped meters. Last but not least, in the five-year period previous to March 1948 the net earnings were only $5,000, which was less than the amount of depreciation. In the year since March 1948, net earnings have totaled $12,600, not including additional expenditures for maintenance. The sum of $500 was saved in chemicals alone.

It must be borne in mind that this situation prevails in numerous cities of other states. Without a doubt, a small water system can be made profitable, can be operated efficiently and is well able to afford the payment of a reasonably good salary to the supervisor or chemist.

After a few months of operation the Board of Public Works stated that their past troubles were due to the fact that "we did not have a licensed operator." In Missouri, the licensing of operators is not mandatory.

Importance of Licensing

Water systems can be operated on a paying basis just as well as any other business. The root of the small-plant

problem is lack of education, but not necessarily on the part of the operators. City councils, boards of commissioners and city managers often do not understand and appreciate the responsibility and skill which a superintendent must have to operate a water system. The writer has seen well qualified men leave their positions as superintendent or chemist and go into a new field in order to make a living. Operators' salaries are inadequate because city governments, even utility ownership—as at Bowling Green—do not realize that the duties of the superintendent are important. Certainly, municipal officials would not care to risk endangering the citizens' health or wasting their money, if they were acquainted with the facts. The present Bowling Green Board of Public Works and Council are well qualified and progressive. After a public relations program, they see the necessity for efficiency in management and are carrying out a $200,000 water utility improvement program.

It might seem that a public relations program aimed at the officials in each individual town is the solution to the problem, but in many cities the turnover of municipal officers is so rapid that such a campaign within the government would be an endless job. Moreover, some well qualified operators are not necessarily gifted as public relations men. With the prestige of a mandatory licensing certificate, the operator or chemist would be better fortified to carry on a public relations program if one was needed.

The efficient operators of small plants, as individuals, do not need help; it is the citizens who require guidance. The man with the ability to manage efficiently the large investment which the water system represents can earn more money by going into some other field, a trend which has been developing since 1942. It is necessary to bring about conditions which will keep these efficient operators on the job and do away with incapable men appointed by uninformed city governments. A mandatory licensing program will impress municipal officials and eventually raise superintendents or chemists to professional status.

It has been reported (1) that approximately 70 per cent of the states either have or are considering voluntary licensing programs and are working toward mandatory licensing. Seven states now have a mandatory law governing competent operation. This is evidence that a great number of persons believe licensing to be the answer.

The objective of the A.W.W.A. is to bring about the production of safe, palatable water and insure good service to the citizens. Great advances have been made, but until a method is found which will keep responsible and capable men in control of water purification, the goal will not be reached.

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In 1939 Frankenmuth, Mich., completed its first water treatment plant and distribution system. The conventional lime-soda softening installation has a capacity of 400,000 gpd. The writer has had the privilege and pleasure of supervising and operating this plant since its completion, and his experiences in the last ten years may, perhaps, qualify him to discuss small water plants.

A small water plant may be defined as one which has a capacity of 500,000 gpd. or less. To classify it according to the manner of operation and the quality of the product it delivers is, in the writer's opinion, unwise and confusing. Most state health departments exercise at least a minimum of control over the manner of operation and this, in turn, should assure a quality product. Since many small plants are run by one man and such operation has a tendency to become routine, an occasional check by some outside agency is highly desirable. Even if such a check serves no other purpose than to keep the operator of the small plant on the alert, it certainly is justified.

Small water treatment installations are not difficult to run, particularly after an operator has had a few years of experience with a plant and a source of supply. Many problems can be anticipated by an intelligent and alert operator and the proper corrective measures taken before they get out of hand. Small plants using surface supplies are frequently subjected to rapid changes in raw-water quality and demand an operating skill usually found only in technically trained personnel. Because men in charge of small plants are engaged in a multiplicity of jobs, they develop into practical, resourceful operators. Small treatment plants should have the benefit of high-caliber operators, and towns should pay good salaries to attract and keep such personnel on the job. A qualified, well paid superintendent can do much more for his community than merely operate its water plant.

This point is very often overlooked by those responsible for employing an operator. Many small towns not only need a technically trained water plant operator, but they can also use a lot of civic leadership. The authors have made the statement that a town should not expect its superintendent to be an expert engineer, chemist, construction man and public relations expert all in one. That observation is perhaps true, but, on the other hand, performing these duties is actually not so difficult, as it merely means applying specialized training where it will do some good. Most small towns can use that type of man and can afford to pay him well for the service he renders.

Water quality control in a small treatment plant is perhaps best accomplished by always allowing a reasonable margin of safety, particularly in the application of carbon and chlorine. The testing procedure should be set up to give the operator actual control of the plant and must necessarily be limited to fundamentals. The analysis work in a small plant must be well organized so that it may be performed along with many other duties.

Small plants are, as a rule, woefully underdesigned, both in size and operating convenience. The writer very definitely feels that it is false economy to underdesign small plants, since the result is almost always higher operating costs. Operating expense continues from year to year, while original plant expenditures are soon forgotten. If design engineers actually operated the plants they design, many modifications would result. A small plant could use automatic control equipment to very good advantage, although such equipment is usually conspicuous by its absence.

It is true that the unit costs in a small plant will be higher than those of a large plant, but there is little to be done about this fact.

Minimizing Service Interruptions Due to Transmission Line Failures

By William W. Brush

A paper presented on June 2, 1949, at the Annual Conference, Chicago, by William W. Brush, Editor, Water Works Engineering, *New York.*

IN water supply operation, the most important item is to maintain at all times the sanitary safety of the water. Next and not far removed in importance, is the continuity of the water service. So serious may be the menace to health, lives and property of the consumers created by a widespread failure of the public water supply that safeguarding against such an interruption—and, if it occurs, minimizing its length—should be primary "musts." Nevertheless, widespread failures of the supply have occurred in cities of substantial size and for periods ranging from several to many hours.

Since the summer of 1948 five such interruptions were reported which developed in cities with combined populations of a million persons. In view of this record, it seems advisable to inquire into the causes of these water system failures and consider what can reasonably be done to minimize their effects. The five incidents will be related in chronological order, the descriptions of the first four being based largely on reports of National Board of Fire Underwriters engineers. The cause of the failure of the supply will be noted and suggestions made as to how the period of interruption might be reduced.

East Chicago, Ind.

The first city on the list is East Chicago, Ind., with a population of 70,000 and large industrial plants. On August 24, 1948, this community was practically without water for domestic use and fire protection for eight hours. This situation was due to a water pipe failure in the pumping station which flooded the building and put all the low- and high-lift pumps out of service. The filtration plant and its nearby pumping station are on Lake Michigan at the extreme northeastern end of the city. The distribution system was supplied by direct pumping, with a 1-mil.-gal. standpipe as a storage and pressure equalizer for the south section, about 3 miles from the pumping station. All nine pumps in the station are electric-motor driven, their installation being divided among three separate rooms with no openings between them below the balcony floor level. Three high-lift pumps were 9 ft. below the balcony; two high-lift pumps were 2 ft. below it; and four low-lift pumps, 6 ft. below. The balcony floor was slightly above the ground level.

At 6:45 A.M., the 30-in. cast-iron high-lift discharge line in the lowest pumproom failed. Within five minutes the water filled the pit, flowed over the balcony floor completely filling the low-lift pit, and also filled the other high-lift pumproom. The engineer of the National Board of Fire Underwriters reported that the break in the pipeline was believed to be due to water hammer or surge when changing over pumps

that discharged into the 30-in. main. At the time of the break the water was being delivered into the system at the rate of 12 mgd. at a 52-psi. pressure.

The most time-consuming job was drying out the electric motors, which was done very expeditiously so that the low-lift pumps started at 12:30 P.M. and the high-lift pumps at 1:30; at 2:10 service was back to normal.

Harvey T. Munn, a National Board of Fire Underwriters engineer, made an inspection and report (1) in which he stated: "The principal lesson from this interruption is that, when a city is dependent on direct pumping at a single station with little storage available, special precautions should be taken to prevent the flooding of the station during breaks, and also to provide automatic pressure control against water hammer or surges on the lines." A contract was let for erecting a 1.5-mil.gal. elevated tank in the southern portion of the city, expected to be in service in the spring of 1949. Munn recommended that:

1. Additional drainage and larger sump pumps should be provided in the three pumprooms.
2. A low wall should be placed along the balcony floor on the inside of the east high-lift pump pit to a height at least above the existing window sills, and a similar wall at the entrance to the low-lift pumproom.
3. Automatic pressure relief valves or surge control valves should be installed on the high-lift discharge lines.
4. Flanged joints should be used on all cast-iron pipe inside the station, and all bends and tees should be firmly supported.

Although definite recommendations for safeguarding the continuity of supply to East Chicago should be based upon an adequate study of the entire plant, the author would make the following suggestions in addition to those enumerated above:

1. Change the pumping plant so that all the electric motors would be at or above the balcony floor level, with the pumps driven by shafts.
2. Provide standby units to approximately 50 per cent of the peak demand, to be driven by other than electric power.
3. Provide piping and valves that would permit operation of the station to at least 50 per cent of the peak demand, irrespective of any break that might occur in the piping, either inside or in the immediate vicinity of the station.

Columbus, Ohio

Columbus, Ohio, with a population of about 340,000, was left practically without water for domestic use and fire protection for several hours due to a break in a 36-in. delivery main. In the business district and central portion of the city, which are on the main service, there was an initial period of approximately three hours with practically no supply, followed by low pressure for about six hours. The north side high service had a greatly reduced supply for about fourteen hours and the east side high-service supply was reduced for about 42 hours, but the west side high service was little affected.

At the main station, there are three delivery lines. The north line, which starts out as 42-in. but shortly reduces to 36-in. pipe, was the one that broke. The two easterly 36-in. mains are cross-connected with the 42-in. main just outside of the station. The break occurred on Saturday, November 13, 1948, at 6:15 A.M., and its location in a field about a mile from the station was not discovered until about 7:00 A.M. The shutoff was completed about 8:30 A.M.

Just prior to the break, the pumping station was delivering about 15 mgd. to the north 36-in. main which broke and about 21 mgd. to the two other mains, with a discharge pressure of 85 psi. When the break occurred, the discharge on the broken line jumped to 31 mgd., with a gradual reduction in the two 36-in. mains until zero was reached at 7:15 A.M. Pressure at the station dropped to 5 psi. at the time of the break and did not start to recover until 8:45 A.M., becoming normal at 12:30 P.M. The broken line was the main supply for the booster stations serving the east side and north side high services. There is no elevated storage on the main low service and relatively small storage on each of the high services.

In his inspection report to the National Board of Fire Underwriters, Harvey T. Munn again recommended the installation of the several 20-in. to 42-in. trunk mains previously recommended in a 1933 National Board report; the completion of the new east side or Alum Creek supply works; the provision of additional elevated storage; and action to "inspect all gate valves yearly and large valves more often, with particular attention to those in and around the pumping stations."

At Columbus, there is need for the following installations:

1. At the main station, valves on the mains and cross connections that can easily and quickly be closed against unbalanced pressure; also surge control valves if surges cannot otherwise be controlled.

2. On the delivery mains into and through the distribution system, quick-closing valves that can be operated by one or two men against the unbalanced pressure created by a break.

3. Additional delivery mains from the pumping station to the distribution system, thus providing for at least duplicate supplies to the various high-service districts.

4. Adequate elevated storage for the main low service.

Indianapolis, Ind.

On December 3, 1948, the water supply for most of the 400,000 persons in Indianapolis, Ind., was interrupted during a period of about four hours because of a break in a 36-in. main outside of the Riverside Pumping Station. The area affected was the low service. The break occurred at 1:35 P.M. on a line which was between a second 36-in. and a 24-in. main on the pumping station grounds. The main was reported to be well cross-connected and valved to the other mains on the grounds and is the largest feeder which extends directly to the business district and to the central portion of the low-service area.

When the break occurred, the pressure dropped to zero at the pumping station and the general location of the break was immediately observed by the station force by the flow of water, which in a short time covered the area to a depth of about 18 in. There was no delay in mobilizing a crew with ample equipment, but as water came up around the 24-in. main, it was believed that that pipeline was broken because it was about 12 ft. away from the 36-in. main. At first, four 24-in. valves were closed, which shut off the 24-in. section without affecting the flow. Then it was definitely established that the break was in the 36-in. main. Three 36-in. valves would normally have isolated the broken section, but one of them was of the horizontal type and would not close. Three additional valves—a 36-in., a 30-in. and a 24-in.—had to be closed to complete the shutoff, which was accomplished at about 5:30

P.M., although somewhat effective pumpage was resumed at Riverside Station at 3:30.

The large flow of water over the soft ground prevented the company trucks, with mechanical apparatus for operating valves, from being driven sufficiently close to the valves to use such equipment, and the valves had to be turned by hand. It was also difficult to locate the submerged operating nuts of the valves, and the unbalanced pressure made it hard to close them, although the bypasses were utilized to aid in equalizing the pressure. The valves generally worked satisfactorily except for one 36-in. horizontal. A regular annual inspection is normally made of the large valves, but because of the pressure of work during wartime and the difficulty in securing labor, no inspection had been carried out since 1945.

The break occurred at the bottom of a 12-ft. section of Class *B* cast-iron pipe, with a wall thickness of 1.109–1.25 in., laid in 1905. A piece about 7 ft. long and 3 ft. wide blew out, and a fracture showed at the spigot end of the pipe, but the bell end did not break. When the failure took place, the pressure of 60 psi. which was being maintained at the Riverside station with a pumping rate of 38 mgd. dropped to zero; at the Washington Street station, which is also on the low service, the pressure dropped from 65 to 20 psi. To aid in furnishing a supply to the low service, connections to the high service were opened. In the low-service area, the pressure of 50 psi. at the water company's office in the business district dropped to 5 psi. in five minutes and did not increase beyond 10 psi. for three hours.

At the Riverside station, it had been the practice to raise the pressure from a normal average of 65 psi. to 75 psi. on second-alarm fires and to 90 on third-alarm fires. Following this break, the Indianapolis Water Co. and the fire department agreed that pressures are no longer to be raised on alarms but on an order from the fire chief or his assistant at the fire, and then only to a maximum of 75 instead of 90 psi.

The information on the Indianapolis incident is also taken from a report by Harvey T. Munn, who stated that most of his recommendations had been planned or proposed by the water company as being desirable to minimize the time of interruption due to breaks in mains. Munn recommended that:

1. In connection with the annual inspections of large valves, particular attention be given to valves in and around the pumping stations.
2. The manholes of the valves in the grounds around the Riverside station be built up well above ground level, the valves to be provided with extension stems and the valve numbers placed on the manhole covers, in addition to the numbers on the upright targets.
3. The ground surface around the Riverside station valves be improved by placing cinders or gravel around the manholes or by building a permanent road in order that trucks and mechanical gate closers may be utilized in any main breaks where water may be encountered.

On the basis of conditions reported at the Riverside station, the author would suggest that:

1. At stations where a break in a delivery line might result in uncertainty about which line had broken, all such delivery lines should be equipped with pitot tubes or other suitable flow-indicating devices to permit immediate location of the faulty pipe.
2. All delivery lines including cross connections should be equipped with

valves which can quickly and easily be closed by one or two men against the pressure created by a break in a pipe; such valves, when immediately adjacent to a pumping station, should be equipped for either power or manual operation; two valves should be installed on each cross connection, so that the failure of one would not necessitate more than one delivery main being shut down in order to make repairs.

3. If the planned or accidental shutdown of a pump or pipe valve might create a surge that would add substantially to the pressure in a delivery line, suitable surge control valves should be installed.

Albany, N.Y.

Albany, N.Y., has an impounding-reservoir supply delivered by gravity to a purification plant which is 10 miles from the city and is connected with the city system by a 48-in. cast-iron main. This main supplies the high service en route, and the low service is fed through regulating valves. The water is delivered through the main to the Loudonville equalizing reservoirs at the northern city limits, which hold about ten days' supply with average consumption. The supply formerly used by the city, obtained by pumping from the Hudson River, is held in reserve and can be put into service in about 48 hours. The normal pressures range from 30 to 95 psi. in both the low and high services.

On January 25, 1949, in order to repair an air valve on the delivery main between the city and the filter plant, the latter was shut down and the 36-in. valve and its 6-in. bypass were shut to close off the 48-in. main near the southern city limits. While the filter plant and delivery main were shut down, the city obtained its normal supply and pressure from the Loudonville Reservoir. The air valve was repaired and the 36-in. valve was operated, but it was noted that there was no resistance shown toward the end of the operation. It was assumed that the stem had broken, leaving the valve partly open. The filter plant was then put back into service. When the reservoirs continued to drop, the 48-in. line was inspected and two leaks were discovered, one a crack in the pipe itself and the other in a bonnet of a 20-in. valve just off the line. As a result, on the morning of January 26 the 48-in. line was shut off south of the reservoir, putting the latter out of service preparatory to repairing the leaks. A continuous drop in pressure in the high-sevice area followed.

Heavy overflowing in the clear-water basin at the filter plant indicated that little or no water was reaching the city, which showed that the 36-in. valve was almost entirely closed instead of being partly closed. Under these conditions, with the Loudonville Reservoir shut off, the supply available for the city was being passed through a 6-in. bypass and the Prospect Reservoir. At noon, without waiting to repair the leaks, the Loudonville Reservoir was put into service and the repairs on the 36-in. valve were started. It was found that the stem was broken near the top of the valve bonnet, with the discs in closed position. The discs were removed, the bonnet was replaced on the valve and the supply from the filter plant was restored at 4:00 P.M. on January 27. The reservoir was then shut off and the leaks repaired.

As a result of the shutoffs for several hours during the morning of January 26, the pressure was greatly reduced in the high-service area, which includes the larger part of the city and is mainly residential in character. Little or no pressure was available in the higher section or western part of the city. It was

not until the night of January 27 that the pressures were fully restored. In the low-service area, the pressures were not seriously affected.

The inspection report by Asst. Chief Engr. Robert C. Dennett of the National Board of Fire Underwriters made no recommendations for changes in the water supply system.

To help meet the Albany situation, it would be advisable to:

1. Provide a ready means of temporarily attaching pressure gages immediately upstream and downstream at each valve on the 48-in. delivery line; and require, as regular maintenance and operating practice, that pressure tests be made upstream and downstream after any valve on a delivery line had been operated.

2. Install on delivery lines some type of quick-closing valve that can be operated readily by one or two men against full unbalanced pressure created by a break, so that such quick-closing valves will be available in an emergency to shut off flow without operating the existing disc valves.

3. Make a careful study of the Albany system to determine whether the failure of any line, valve or other appurtenance on any pipe would, in all probability, interfere with delivering a satisfactory pressure during the period required for repairs if the storage available is likely to be exhausted in the meantime.

Taunton, Mass.

On March 11, 1949, at about 2:00 A.M., a drop in pressure at the Harris Street station at Taunton, Mass., indicated that a break had occurred on the gravity delivery pipeline that extends for approximately 7 miles from Elders Pond to the station. By patrolling the line, the break was found at about 5:30 A.M.

This gravity line normally provides the entire supply for Taunton, a community of approximately 38,000. An infiltration basin at the Harris Street station can furnish a reserve supply of about 2 mgd. Of the total public supply, approximately one-third is used for residential consumption and two-thirds for industrial plants. The water supply is obtained mainly from Assawompsett Pond, the largest natural pond in Massachusetts. After being pumped, the water flows through a pipeline for about 1½ miles into Elders Pond. The consumption averages approximately 3.25 mgd.

The single 30-in. delivery main from Elders Pond has been in use since 1894. The break occurred about 2 miles from the pond, where the pipe is in earth fill and passes over a stone-slab brook culvert in a pasture. The bell of the joint that rested on the stone culvert was split on the top and near the bottom, and about 4 ft. of the side of the pipe was broken out. Superintendent Arthur C. King reported that settlement of the pipe in the adjacent fill probably caused the break, which was "mostly a new fracture, although parts showed that there had been a crack for some time."

When the supply reaches the Harris Street station, it is delivered by direct pumping pressure into the distribution system at approximately 70 psi. If a fire occurs, the pressure is raised to 100 psi. According to the 1947 annual report of the Board of Water Comissioners, which is the last printed report available, during 1947 the pressure was raised 215 times on account of fires. After the break had occurred, an effort was made to shut down the pipeline, which is equipped with 30-in. horizontal geared disc valves located in small manholes. Because of the impossibility of shutting off the supply pipe except

in the most serious emergencies, the valves on this supply line had not been operated for a long time. In trying to shut off the valve nearest the break completely, the operating stem was broken. The next valve upstream was tried, but its cast-iron gear broke. Most of the water was emptied out of the main by opening the drain valve between the two broken valves, and the break was repaired by using lead wool instead of yarn, which temporarily shut off the water while the joint was being poured.

The valve with the broken stem was repaired and at 2:00 P.M. on Saturday, March 12, the refilling of the supply line began. Three hours later the pumps were started at the Harris Street station. During the repairs the infiltration basin and emergency sources maintained a pressure of about 45 psi., as compared with a normal of 85 psi. Water was supplied for most of the congested factory section, but none was available for some of the higher residential areas. An emergency supply of about 600 gpm. was obtained for 22½ hours by taking water from an institutional system. To deliver this water, a fire pump relay was used. Five fire pumpers were connected up by one line of 3-in. and two lines of 2½-in. hose, the pumpers being placed approximately 1,000 ft. apart.

Obviously, the 20-mil.gal. distribution reservoir urgently recommended by Supt. King for many years should be built on the site purchased for that purpose twenty years ago. Furthermore, additional delivery lines from the pumping station to the distribution system should be provided, as the present lines are inadequate.

At Taunton, the interruption of the supply is attributed to the unwillingness of the Taunton financial authorities to furnish the necessary funds for an adequate water system to meet the demands of the consumers. Under such conditions, it would serve no useful purpose to attempt to detail the improvements in the Taunton water system that should be made in addition to the two items mentioned.

Check List

Although American water systems have a well deserved reputation for wholesomeness of supply and continuity of service, weaknesses exist at most plants in equipment, design and standards of maintenance and operation. Such weaknesess are fundamentally due to unwillingness on the part of the officials controlling the finances to expend sufficient money on the water system to provide improvements and personnel required for adequate safety, sufficiency and continuity of the supply.

In every water system, analyses should be made of the probable duration of interruption in the supply that would follow if any failure occurred in the delivery system. In a pumped supply, the station and delivery mains would be included. The desirable frequency of such analyses could only be determined by the local situation and should be reconsidered periodically in the light of changed conditions.

As an aid in studying possible failures and resultant interruptions of supply, a check list has been prepared to include items that are likely to be pertinent for many water systems. The local situation will indicate additions that should be considered by the superintendent.

The check list is as follows:

1. Are there flow-indicating devices in the station that will definitely show which one of two or more delivery lines has broken?

2. If a delivery pipe or valve breaks in the station, could the resultant flow

cause a shutdown that might seriously affect distribution pressures?

3. Are all electric motors and other electrical equipment essential for station operation so located as to be free from flooding danger?

4. Are capacities of pumps and power used such that, with any pump under repair, a breakdown of any other pump or power failure would seriously interfere with the maintenance of service?

5. If there are two or more delivery lines, are these lines cross-connected inside or outside the station with a valve on the cross connection; if so, and a cross connection valve failed, causing two lines to be shut down, could the system function safely?

6. Under the operating conditions, could any situation arise that would create a substantial surge or water hammer on the delivery lines either in or outside of the station; if so, are effective surge control valves installed?

7. Are delivery lines equipped with effective check valves to prevent backflow into the station if a line break occurs?

8. Are valves on delivery lines inside and outside the station of a type that can be quickly closed and easily operated by one or two men?

9. Are automatic air valves located at summits on delivery lines?

10. Are two or more delivery lines laid so close to one another that a break in one might dangerously undermine an adjacent main?

11. Are means provided to drain quickly any portion of a delivery main for repairs?

12. Are hydrants or other connections to delivery mains provided for attaching pressure gages at one or more points between adjacent valves on the respective delivery lines?

13. Are any of the delivery lines laid over and just above an unyielding structure, such as a masonry culvert, without special construction to minimize the probability of settlement on either side, which might cause a leak or strain the pipe wall to the breaking point?

14. Are reserve delivery main capacity and distribution storage in combination sufficient to provide, in a reasonable manner, for the consumer demands during the maximum period of interruption of delivery of supply that it is believed might occur under peacetime conditions?

Although the foregoing items in the check list might readily be increased, it is felt that they are sufficiently numerous and important to serve as an aid to a superintendent who is interested in analyzing the delivery main installation in the system under his charge.

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Discussion

S. Logan Kerr

Pres., S. Logan Kerr & Co., Inc., Philadelphia.

The author has cited a number of serious failures in the transmission systems of municipal water supplies. It is most helpful to all designing engineers to have complete reports of such occurrences and analyses of the causes with recommendations for correction and prevention. Such studies form a

very vital contribution to engineering information on water works design. It is hoped that the practice of making this kind of report will be continued.

Although many of the recommendations listed by the author could well have been incorporated in the original design, there are some factors which always seem to have a question mark opposite them during the progress of the design work on a project. These items usually fail to get the consideration which they merit in advance of construction or in advance of operating failures.

One particular item which falls in this category relates to the surge or water hammer conditions which may occur during routine operation, as well as under emergency conditions. There has been a pronounced tendency to omit or at least postpone consideration of surge control devices until operating conditions render them necessary. This situation is probably due to the feeling that studies on water hammer undertaken during the design stage of a project become so complex that a calculated risk is warranted—namely, to wait and see how things come out before investigating or providing surge control apparatus. Prior to 1933 there was often good reason for such a practice to be followed, as the theory of surges was not too well understood, nor was this information generally available in American engineering publications.

The activities of the A.S.M.E. Committee on Water Hammer, initiated in 1931 with the cooperation of the A.W. W.A., the A.S.C.E. and the Engineering Institute of Canada, have brought into engineering literature more and more articles (1–11) on this subject. It is now possible to refer to the publications of these societies and secure for study an excellent series of technical papers dealing with almost every aspect of water hammer.

Surge Studies

During the last eight to ten years careful investigations have occasionally been made concerning the effect of surges or water hammer on the pumping plant and transmission main design in advance of construction. Among these can be cited the low-lift pumping station for the Toledo, Ohio, water supply; the recently completed pumping plant and transmission main for Toronto, Ont.; and the pumping plant and transmission main for the Republic Steel Corp. plant at Gadsden, Ala., and for the Long Lac Paper Co., in western Ontario. In each of these projects, the potential surge conditions were analyzed; the permissible pressure rise was fixed; the timing and type of control and check valves were determined; and the necessary remedial devices were specified as part of the initial installation.

In a few of these plants, it was possible to make performance tests of the line by tripping out pumping units with surge relief devices installed. There was always a remarkably close agreement between the theoretical analyses, made in advance as part of the design work, and the actual surges experienced by the plant in ordinary operation or under emergency conditions, such as might follow a power failure to motor-driven centrifugal pumps. In other plants, when failures occurred because of the omission of remedial devices in the initial design, surge studies were undertaken and corrective devices installed. Where these were properly applied, the operating record has been most satisfactory, and sometimes there has not been a single water main fail-

ure due to water hammer in a period of fifteen to eighteen years.

Two questions usually arise in relation to advance studies on surges. The first is: How can such studies be undertaken during the design stage? The answer to this question is simple. Once the general layout of the system has been made, the length, diameter, thickness, material and capacity of the pipe, as well as the type and size of pumps, can be determined. The normal operating pressures at various points in the system can be computed and the allowable maximum pressures fixed. By this means, the margin for water hammer is found and the design should then provide either safety factors large enough to withstand such conditions as might be encountered, or suitable remedial or control devices. It is important to note that there is no single magic device that will cure all surge difficulties. It is only by a study of both normal operating conditions and possible emergency conditions that the proper valve-timing, surge-damping or relief devices can be selected.

Basic Factors

A few basic factors can be checked to indicate whether surges of serious proportions will occur in any given system, once the physical, hydraulic and operating characteristics are established. The following twelve questions will, for most transmission mains supplied by motor-driven centrifugal pumps, give a clue to the seriousness of the surge problem for that particular main:

1. Are there any high spots on the profile of the transmission main where a vacuum can occur and cause a parting of the water column when a pump is cut off?

2. Is the length of the transmission main less than 20 times the head on the pumps (both values being expressed in feet)?

3. Is the maximum velocity of flow in the transmission main in excess of 4.0 fps.?

4. Is the factor of safety of the pipe less than 3.5 for normal operating pressures?

5. What is the natural rate of slowing down of the water column if the pump is cut off? Will the column come to rest and reverse its direction of flow in less than the critical surge wave time of the transmission main?

6. Will the check valve close in a time less than the critical time of the transmission main?

7. Are there any quick-closing automatic valves set to open or close in less than 5.0 seconds?

8. Would the pump or its driving motor be damaged if allowed to run backward up to full speed?

9. Will the pump be tripped off before the discharge valve is fully closed?

10. Will the pump be started up with the discharge gate valve open?

11. Are there booster stations on the system which are dependent on the operation of the main pumping station under consideration?

12. Are there any quick-closing automatic valves used in the pumping system that are inoperative with the failure of pumping system pressure?

If the answer to *any one* of Questions 1–7 is affirmative, there is a good possibility of having serious surges. If the answer to *two or more* of Questions 1–12 is affirmative, surges will probably be experienced and their severity will be in some proportion to the number of "yes" answers.

It is not feasible to make general recommendations on the type, size and application of surge control equipment for all plants. Several possible solutions should be considered for any individual installation and that one selected which gives the maximum protection for the least expenditure. Surges can often be reduced substantially by using bypasses around check valves, cushioning check valves for the last 15–20 per cent of the stroke or adopting a two-speed rate of valve stroke. Air inlet valves may be needed, or the preferred solution may be to use a surge damper or air chamber. In a number of plants no devices will be required to hold the pressure rise within safe limits.

It is essential to coordinate all the elements of a system properly and to have operating practice conform to the requirements for safety. As changes take place in the system demand, it may be necessary to revise and review the surge conditions, particularly if the capacity is increased, additional pumpage or storage is added or booster stations are planned.

Value of Prior Studies

The second common question on advance surge studies is: How effective are the recommended solutions to the problem when the equipment is placed in operation? If a competent investigation was made during the design stage and the recommendations arising from it have been carried out, the final plant has almost always operated without any damage due to water hammer. The agreement between the theoretical analyses, properly applied, and the actual tests of installations has been extremely close. When a surge study was not undertaken and dangerous conditions existed, there have almost invariably been serious surges, and sometimes costly damage has resulted.

The time and effort spent on a surge study in advance of the final design is the least expensive means of insuring against surges. The elastic-wave theory has been completely proved in actual practice, and it remains only for the water industry itself to take the initiative in making these studies without waiting for serious failures to occur before installing surge control devices.

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Harvey T. Munn

Hydr. Engr., National Board of Fire Underwriters, Chicago.

The author has described in a very able and comprehensive way the partial or complete water supply interruptions from pipe failures which have occurred in recent months in five midwestern or eastern cities. He has also outlined definite recommendations which should be applied in these particular cities for minimizing such interruptions. In addition, at the end of his paper is included a general list of fourteen separate items dealing with reliability which would apply to most water systems. It is believed that these items should be considered carefully and should be put into effect if possible.

The writer is in agreement with the author on these recommendations, but it is thought that a brief discussion and some additional observations resulting from the writer's contacts with a large number of cities may be of general interest.

Interruptions to the water supplies of the larger American cities are generally infrequent, but when they do occur they are usually of a serious nature and are often of rather prolonged extent. The public, as a rule, appears to take it for granted that there will always be a sufficient quantity of potable water available at suitable pressure and does not always realize the problems to be met and solved in order to maintain an adequate and reliable supply continuously. When water is shut off for any length of time, it causes a great deal of inconvenience to the citizens as a whole; serious conditions often result in hospitals, schools and industrial plants; and, of course, fire protection is reduced or sometimes practically eliminated during the period of the interruption.

The National Board of Fire Underwriters and the fire insurance interests are vitally interested in the adequacy and reliability of the water supply. Unless a sufficient quantity is available, the fire department may be greatly handicapped in extinguishing fires or in preventing them from spreading to adjoining buildings. When interruptions to the water supply occur, the fire department cannot cope with large fires, automatic sprinkler systems served directly from mains will not function and, under adverse conditions, fires may assume conflagration proportions.

Major interruptions to a water supply may be due to any number of factors, such as floods, tornadoes or failures in steam or electric power. The principal cause, however, appears to be breaks in transmission lines, piping in or around the pumping stations or large distribution system mains. The author's paper and this discussion are confined to interruptions from failures in transmission lines or in other pipe installations.

It is recognized that breaks in large mains occasionally will occur in any water system and may often be due to factors unknown to or beyond the control of the water department. Some major considerations, however, should be kept in mind in the design and operation of any water system to minimize the time of interruption from these breaks.

Plant Piping Arrangement

In planning a new water plant or in making additions to existing plants, the design and layout should be carefully examined to see what effect possible breaks in piping may have on the de-

livery of the supply. This investigation should apply to all piping in and around the source of supply and the purification plant, and to suction and discharge piping around the pumping stations. It will often be found that the duplication of certain lines, or the insertion of additional valves in some of the looped piping, will permit the segregating of portions of the lines in the event of breaks and usually will enable the plant to continue in operation. Occasionally interruptions have been caused by pipe failures inside the pumping stations which have flooded all the pumps and forced complete shutdowns. Special provisions should be made to prevent the flooding of stations, including measures for the relief of pressure surges and the segregation of pumps and piping.

Distribution System Layout

In making studies and plans for reinforcing and extending distribution systems, a great deal of attention, of course, must be given to providing sufficient quantities and pressures under normal operating conditions. It is believed, however, that these studies should be supplemented by an analysis of the system from the standpoint of reliability and the possible effect of breaks in the larger mains. In some of the smaller systems, a break in one feeder line will cause a total interruption. In a larger system, a single break may cause partial interruption to the whole system, or other breaks may greatly reduce the supply to large, important areas. It is generally better to lay two or more mains using different routes rather than a single large main of equivalent capacity. By looping and properly valving the lines, a fair supply may still be available if a break should occur in one of the mains. The introduction of elevated storage, either in reservoirs or in tanks, often will furnish sufficient supply to take care of interruptions. Storage should be properly located and should be connected to large mains which ought to be looped and so valved that a break will have the least possible effect in eliminating the storage.

Pipe and Valve Records

It is essential even in the normal operation of water systems, but particularly when emergencies arise, to have clear and easily understood records of the piping in and around the plants, as well as of the distribution system. It is a great aid in any emergency to have a large plat showing all piping and valves posted at the pumping stations, with the valves numbered and with corresponding numbers placed on or near the individual valve to identify it readily.

Distribution records should include a large, general map of the entire system and also sectional plats, showing measurements to mains and valves. The system of distribution records recommended by the A.W.W.A. should be followed whenever possible. It is essential for any system of records to be in a form clearly understood by field men, with copies supplied to them to aid in locating mains and valves.

Gate Valves

Gate valves are installed in pipelines primarily to stop the flow of water and permit sections of mains to be isolated if there is a break or during construction work. When large pipe failures occur, if the distribution force can promptly determine which valves must be closed, locate them readily and close them without delay, the time of interruption may usually be greatly reduced.

It is important that the valve covers be removable without difficulty. It has been noted in a number of cities recently that many valve covers are paved over, requiring considerable time for their removal. Most cities with large-size mains now have mechanical valve-operating machines which greatly reduce the time of operation, particularly for large geared valves. In some large breaks in unpaved areas, however, it has not been possible to use these machines because of the soft ground around manholes and the flow of water. In certain cities, the large valves in and near the pumping stations are seldom operated, but it is believed that they should be given special attention, as it is in this area that breaks are often likely to occur.

Many cities during and since the war have not been able to make regular inspections of gate valves because of the lack of experienced personnel or of inability to get proper equipment or spare parts. It is felt that all valves, and particularly large ones, should be inspected and operated at least once a year to insure their being in good condition when needed. The large valves, especially those of the open-geared type, usually need special attention, nor should the bypasses on the large valves be overlooked. In making emergency shutoffs, valves operating in an opposite direction from the standard may cause confusion and should therefore be clearly marked in the field and on the valve records. The nonstandard valves should, of course, be changed as soon as possible.

Emergency Provisions

Most water departments have a good system set up for emergency operations, but breaks often happen at night, on holidays or on week ends, when it is sometimes difficult to assemble crews and equipment on short notice. One or more responsible distribution employees should always be on duty, and crews should be quickly available at all times. Trucks or cars equipped with radios or mobile telephones often will reduce the time of response. Additional telephones with private or unlisted numbers should be installed at the distribution shop and at the main pumping station. During interruptions the regular telephones are usually congested by calls from the public, and necessary calls cannot be put through. It was noted that in three of the midwestern cities which had interruptions, the system of communication played a very important part.

Summary

It is believed that five basic considerations should always be kept in mind in the operation and maintenance of any water system in order to minimize the period of interruptions from breaks in large lines:

1. Duplication of piping at the plants and of large mains, should be provided wherever possible.
2. There should be sufficient interconnections between mains and sufficient valves to segregate the lines.
3. Valves should be maintained in good condition, so that they may be located and operated without delay.
4. A system of accurate and easily understood records should be established, with copies available for field men.
5. Provision should be made for good communication systems and definite arrangements for emergency response at all times.

Use of Models in Solving Flocculation Problems

By S. L. Tolman

A paper presented on April 20, 1949, at the Indiana Section Meeting, Indianapolis, Ind., by S. L. Tolman, Sales Mgr., San. Eng. Div., Jeffrey Mfg. Co., Columbus, Ohio.

IN most pretreatment plants, the raw water is thoroughly mixed with the coagulant, after which it passes to basins where it is slowly stirred to build up a satisfactory floc. It then goes to sedimentation basins for removal of the floc so that the settled water is comparatively clear before passing to the filters for final processing.

Rapid mixing is accomplished by the introduction of coagulants in places where the flow is turbulent—ahead of bends in pipelines, just ahead of pumps, in baffled chambers or into tanks equipped with mechanical stirring devices. Mixers consist of one or more turbines or propellers mounted on vertical shafts, or paddle wheels (somewhat similar to those used on flocculation mechanisms) mounted on horizontal shafts but rotating comparatively swiftly. All of these devices are designed to keep the water in constant agitation so that the chemicals and water will be uniformly mixed before leaving the basin. The detention time in these basins varies from 30 seconds to 5 minutes.

Slow mixing is accomplished by baffled chambers using around-the-end or over-and-under baffles, or by mechanically operated paddle wheel mixers of the horizontal- or vertical-shaft type.

Baffled mixing chambers attain good results at a fixed rate of feed, but if the flow varies they are not satisfactory. At low flow flocculation is incomplete and deposits occur in the chamber, while at high flow the loss of head is excessive and velocities may be so rapid as to break up the floc. Mechanical mixers give constant rotational velocities with a minimum of loss of head regardless of the rate of flow through the basin, and therefore, within the usual variations in flow encountered at most plants, the water leaving these mechanical mixers is always uniformly well flocculated.

The vertical-shaft mixers consist of a vertical shaft with radial arms attached, to which paddle blades are fastened. The horizontal-shaft type is of similar construction, but uses a horizontal shaft placed either parallel to the direction of flow through the basin or at right angles to it. Most flocculation basins are divided into compartments by means of baffles. The arrangement of paddle arms, paddle blades and baffling varies in accordance with the standard practices of the various manufacturers. Detention periods range from 40 to 60 minutes, and outer peripheral paddle speeds vary from 0.75 to 1.50 fps.

Mechanical Flocculation

Practically all modern plants provide for mechanical flocculation, and this trend will continue. Settling basins have grown smaller and smaller as better flocculation of the raw water is provided for ahead of these basins. This trend has largely been the result of more efficient mechanical mixers, which have produced quick-settling floc. For settling basins, both round and rectangular tanks are used, although the latter predominate, especially in the larger installations. Some tanks are either partially or completely equipped with sludge removal mechanisms, and the trend is toward more mechanical sludge removal. The reasons for mechanical removal are many: a smaller original plant investment, as no additional basin capacity is necessary for shutdowns for cleaning purposes; a saving in manpower for cleaning basins; and a reduction in the tastes and odors which are caused by decomposing organic matter deposited in the basins.

On some of the larger projects, where space is at a premium, two-story basins have been constructed. These basins are usually of rectangular shape and are divided into an upper and lower chamber by means of a horizontal floor halfway between the roof and the bottom of the basin. Examples of this construction are found at the water purification plants of Milwaukee, Chicago and Los Angeles.

Detention periods may vary from two to four hours. Increasing attention is being given to basin inlets and outlets in an effort to eliminate short-circuiting. Diffusion walls at both the inlet and outlet are often employed, and rather widespread use of overflow troughs, extending well back toward the inlet end of the basin, helps to take the clear effluent off gently and uniformly over a large percentage of the settling basin area.

Formation of Satisfactory Floc

The mixing of chemicals with the untreated water must be very thorough so that uniformly dosed water is obtained before it goes to the flocculation basins. If this objective is not achieved, satisfactory floc formation is impossible. Incompletely formed floc will result from underdosed water, and too light a floc will be formed from the overdosed water. This statement can easily be demonstrated in the laboratory, and it can further be shown that, for any given condition of raw water, there is only one correct chemical dosage which will produce the best settling floc and completely remove all turbidity present in the raw water.

Assuming a satisfactory initial mixing of the raw water, the flocculation must be carried to such a degree that chemical reactions are complete, and all turbidity must be incorporated into the floc particles so that the resulting floc will have the best settling characteristics possible. This means the forming of compact floc particles in which the ratio between the weight of the floc particles and their surface area is a maximum. This requirement applies in all problems of floc building, whether for turbidity removal or softening. The floc particles need not necessarily be of large size, as often a smaller, more compact floc will settle much faster than a larger, fragile one. Moreover, a small, compact floc is much less subject to mechanical breakage in passing through pipes, bends and the like.

The design engineer at once will ask just how satisfactory flocculation can best be accomplished. It can be done only by a mechanism designed to produce the type of floc outlined above, and to do this most efficiently requires a basin designed to retain the water in the mixing chamber for a sufficient length of time to produce the desired results.

In addition, to keep the initial investment to a minimum, this basin must be designed to minimize short-circuiting of the flow through it. It should be remembered that, unless the water passing to the sedimentation basins is properly conditioned, complete removal of the floc particles is impossible and the settled water going to the filters will put a heavier burden on them than they were designed to handle; the result will be short filter runs, buildup of floc particles on the filter sand and an unsatisfactory water coming from the filters.

Use of Models

Models are of great value in arriving at a correct solution of flocculation problems. It has been shown (1) that when a model is built on a true scale relative to the prototype, and the flow passing through it is in accord with the laws of hydraulic similarity, it can be used to predict faithfully the hydraulic characteristics of the prototype. The detention period in the model will be the detention period in the prototype divided by the square root of the scale ratio.

Similarly, all other factors causing a disturbance of flow must vary accordingly. When these conditions are met, the hydraulic effects will be the same in the model as in the prototype, unless the scale ratio is so large that viscosity and surface tension effects are disproportionate. Models with a scale ratio of up to 30:1 may be confidently used to predict a variety of hydraulic effects.

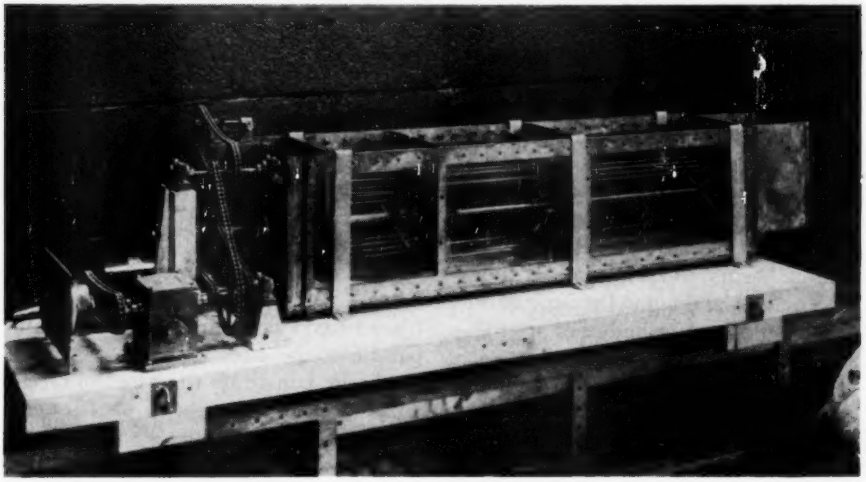


Fig. 1. Flocculation Basin Model

The use of models is twofold: [1] to show just how the flow will pass through the structure; and [2] to demonstrate the minimum size of structure necessary to produce a well flocculated water. In such studies, the hydraulic conditions prevailing in any basin will be expressed in terms of the dispersion index, which has been defined as the ratio of the time at which 90 per cent of the flow has passed out of the basin to the time when the first 10 per cent has passed out (2). This index can be determined by dye or salt added to the influent of the model and recovered quantitatively at the effluent end. If the flow passed through the model with perfect uniformity, the dispersion index would be 1.0, but since this is not feasible, an index as small as possible is desired, and one that has its peak at as close to the theoretical detention period as possible. Well designed flocculation basins should have an index of 2.5 or less, and a good sedimentation basin should have an index of approximately 2.0.

Shown in Fig. 1 is a 25 : 1 scale model of a flocculation basin 64 ft. 6 in. long, 16 ft. 8 in. wide and 15 ft. 6 in. deep. At a design rate of 4.4 mgd., the detention time for flocculation is 40 minutes. Following the law of dynamic similarity, the detention time for flocculation in the model is $\frac{40}{\sqrt{25}} = \frac{40}{5} = 8$ minutes. Since the model has a capacity of 7.95 gal., the rate of flow must be 0.994 gpm., or 3,800 ml. per minute. The model used employs a stirring device in the flocculation basin called a "Floctrol." *

The Floctrol consists of a stirring mechanism designed to accomplish tapered mixing by progressively decreasing the rates of agitation as the flow passes through the basin, and to provide increasing time periods in the compartments in the direction of flow through the basin. The compartments are of varying lengths, with the one at the inlet end the shortest and each succeeding compartment larger than its predecessor. Also, the highest rates of agitation are in the first compartment, and the lowest in the last compartment. This is accomplished either by varying the rotational speed of the paddle wheels in the various compartments, or by changing the number of paddles or the number of paddle arms and paddles, or by a combination of the two. The rates of agitation are made less in each succeeding compartment by changing the number and location of the paddles.

The rapid mixer consists of two turbines mounted on a rapidly rotating vertical shaft. A number of paddle wheels, using two or four sets of arms placed upon horizontal rotating shafts parallel to the direction of flow through the basin, constitute the Floctrol mechanism. The slow speed shaft, upon which the paddle wheels in the third and fourth compartments are mounted, extends the entire length of the basin and projects through the inlet wall.

The paddle wheels in the first two compartments are mounted upon a hollow shafting, through which the other shaft extends. This likewise projects beyond the inlet wall, and is provided with a stuffing box at either end, and at the entrance to the inlet wall. Both shafts have sprockets keyed to them and are connected by chains to the drive units. Thus all the drive mechanisms are in a dry well, making it easy to change sprockets if the mixing speeds are to be varied.

* A product of the Jeffrey Mfg. Co., Columbus, Ohio.

A unique system of baffling is used to reduce short-circuiting through the basin as much as possible. The baffles consist of solid partitions with a port of communication from one compartment to the next at the center of rotation of the mechanism. Just beyond each port is placed a rotating baffle attached to the rotating shaft. This baffle, which is of larger diameter than the port opening and is usually placed about 1 ft. from the port, causes the flow to mushroom out and pass readily to the outer periphery of the rotating mass. Centrifugal force due to the rotating blades tends to hold this mass near the periphery until it is displaced by the incoming flow which forces it to the center where it passes out through the center port and on to the next compartment. Thus, water is kept in the compartment for a time quite close to its theoretical displacement period. The use of more compartments will achieve better results, but for most plants the design shown in Fig. 1 is moderate in cost and its hydraulic characteristics are so good that it is questionable whether additional expense is warranted.

Flocculation Tests

If the hydraulic efficiencies of the basin are high, it is a logical assumption that the flocculation will be satisfactory, provided the flocculation mechanism can produce a good, quick-settling floc. Actual flocculation tests must be run separately, however, as it is obvious that these cannot be made with the short eight-minute detention period used in this basin for hydraulic tests.

The floc tests should be run using the same detention time in the model Floctrol as will be used in the plant. The settling basin should be so proportioned that its depth and area will produce the same actual horizontal velocities, and overflow rates of the same magnitude, as will prevail in the prototype. The model thus operated will give the same result as can be expected later in the full-size plant. With a model, it is comparatively easy to change the design of baffles, inlet and outlet ports and the like until the best design is determined. Furthermore, the visual observation of floc formation under conditions of continuous flow is of great value in arriving at the correct detention time.

To illustrate, the author was recently asked to demonstrate to a city design department the correct period for producing a well coagulated water. This city had from time to time added a number of large sedimentation basins and yet had increased the flocculation facilities but little, until the mixing time was reduced to a bit less than twenty minutes. The model was set up and operated under continuous-flow conditions, but, although it at once produced a better floc in twenty minutes than was being achieved in the plant, it was not satisfactory. The model soon demonstrated that a 40-minute flocculation time should have been provided. At this plant, because of poor conditioning of the raw water, improperly treated water was passing through the sedimentation basins and onto the filters, with a consequent buildup of material on the sand grains so that complete replacement of the filter sand will be necessary in the near future. A further analysis showed that, with the addition of proper flocculation facilities, the present basins would be adequate for many years in the future.

Flocculation is probably caused by the trailing eddy formation created by the passing of paddle blades through the medium to be stirred. These eddy currents cause the particles of chemically formed precipitate to revolve and, combining with other similar particles, to grow in size as they pass through the basin. Also, the floc particles, because of their opposite electrical charge, attract the turbidity particles, which become incorporated in them.

If the above theory is true, and it seems reasonable to suppose that it is, then the larger the number of eddy currents caused by paddles passing through the water, the better the floc formation will become. The eddy formations produced by narrow and wide blades passing through water with the same linear velocity have been compared. Since the narrow blades cause many more eddies than the wide ones, it is believed that, for the most efficient design, paddle wheels should be equipped with many narrow blades rather than fewer wide ones.

References

1. Gibson, A. H. *Hydraulics and Its Applications.* D. Van Nostrand Co., Inc., New York (1930).
2. Morrill, A. B. Sedimentation Basin Research and Design. Jour. A.W.W.A., **24**:1442 (Sept. 1932).

Willing Water Radio Transcriptions Available for Public Relations Use

Willing Water and the local radio station can combine to improve a water utility's public relations if advantage is taken of the special broadcasting records provided by courtesy of the Cast Iron Pipe Research Association. Available without charge to prospective users through A.W.W.A. headquarters, each disc contains eight transcribed announcements designed for an equal number of one-minute radio "spots."

The announcements are designed to awaken a community's interest in and appreciation of its water supply, and may be utilized in series form. Introduced and ended by appropriate gurgles and splashes, the voice of Willing Water is heard dramatically outlining the role of the water system in such public services as: fire protection; the elimination of typhoid fever; making possible indoor plumbing and waterborne sewage disposal; the functioning of industry and the attraction of new industrial plants; and lawn irrigation.

It is believed that many stations will donate the time for public service announcements of this type; however, the cost for one minute station announcements during the evening hours is less than might be realized. Some typical examples include $9.00 at Johnstown, Pa.; $10.00 at Lynchburg, Va.; and $32 at Birmingham, Ala. No advertising or mention of any organization other than "your public water supply system" is made on the records.

Utility managers who wish to use the transcriptions should first ascertain the availability of time on their local radio stations and, if possible, make concrete arrangements. A request to A.W.W.A. headquarters will suffice to procure a disc without charge. So that those who developed the project may better evaluate its usefulness, however, it is requested that as much information as possible about the projected broadcasts be included in the letter, particularly the location and wave length of the radio station, the dates and, if possible, times that have been scheduled, and, of course, the name of the water utility being publicized. A follow-up report on the effectiveness of the broadcasts would also be appreciated.

Using Runoff for Ground Water Recharge

By Edwin T. Erickson

A paper presented on Nov. 4, 1948, at the New Jersey Section Meeting, Atlantic City, N.J., by Edwin T. Erickson, Asst. Engr., Div. of Water, Newark, N.J.

NEWARK, N.J., receives its water by gravity from two surface supplies approximately 25 miles away. The Pequannock Watershed, controlled completely by Newark, supplies two pressure zones located in the higher sections of the city, and the Wanaque Watershed, in which Newark is a partner, supplies the pressure zone in the lower industrial part of Newark. An independent high-pressure fire system is maintained in this industrial area by means of a pipeline from the higher Pequannock zone.

In addition to the municipal surface supplies, certain industries use privately owned wells to supplement their demands. The well water is employed principally for cooling purposes, because an even temperature of about 57°F. is maintained throughout the year. Since the ground water level has been receding annually and has now reached a low point which is undesirable, a solution for raising the level in the wells would be most welcome to the industrialists.

Because the lower 21.4 square miles of the total 63.7 square miles of the Pequannock Watershed is uncontrolled, its maximum yield is dependent upon the immediate sale of runoff from the uncontrolled area as it occurs. Because under present conditions immediate sale is not made, this runoff is lost, as unavoidable waste, in the form of overflow at the Macopin Intake Dam. The director of plant engineering, in searching for means of recharging the wells at P. Ballantine & Sons, suggested the possibility of using the Macopin overflow for recharge water.

The temperature of Pequannock water is observed daily at the Newark City Hall. A low of approximately 36°F. occurs during January and February, from which the temperature gradually rises to a peak of approximately 78°F. during July and August. Pequannock water below 57°F. may be expected at the city from about October 1 to June 1 each year.

The author was assigned the work of making a study of the possibilities of transporting the Macopin overflow to the Ballantine wells. It was found that sufficient water, in addition to that needed for consumption, could be brought through the pipelines to the Cedar Grove Reservoir and then to the distributing point at the Bloomfield Avenue Tower. From the tower the high-pressure fire system was the only available line directly to the vicinity of the wells.

1948 Experiment

From separate hydrants in the high-pressure fire system, temporary 3- and

4-in. metered connections were made to three wells. Two other wells were temporarily supplied by 4-in. connections from the plant's high-pressure piping. From March 15 to June 17, 1948, a total of 128 mil.gal. was delivered to five of Ballantine's wells on 66 days, or an average of 1.94 mgd. This was equivalent to only 0.1 per cent of the 10,498 mil.gal. of overflow that occurred at Macopin Dam during the same period. Although the high-pressure fire system was used to supply the recharge water to the wells, it was selected for this purpose not because of its high pressure but because it was the only available line which could transport Pequannock water directly without interfering with the general-use service. After the experimental stage, other arrangements will most probably be made to transport the overflow water to the wells indirectly by way of the low-pressure system. From the high-pressure hydrants, water was delivered to the well shaft at zero pressure when the pump had been removed, or at approximately 5 psi. when it was found necessary to revolve the pump propeller in the reverse direction.

The main difficulty for the Newark Div. of Water during the 1948 experiment was to maintain satisfactory pressures in the high-pressure fire system. A method was established to reduce quickly the quantity of recharge water used, in the event that the pressures anywhere in the high-pressure system were to be drawn down below the desired minimum, especially if a serious fire occurred. During the day special attention was given to any conditions that might affect the pressure in the fire system. Fortunately, the pressures were normally higher at night than in the daytime. The telephone numbers at the Ballantine wells were listed at the water division switchboard for the use of the engineer or others in an emergency. Upon notice, the supply could have been shut off in the time necessary to close the hydrants or valves by men nearby at the engine rooms of the plant. No emergency occurred to make this procedure necessary, however.

Results of Experiment

Experimental data were obtained from records of the Ballantine wells, as compiled by the plant engineering department. Just prior to the experiment, on March 15, 1948, the standing water level of the wells was approximately 130 ft. below the ground surface. On April 2 it was found necessary to interrupt the experiment for eleven days in order to use the high-pressure fire system piping for other purposes. By that date recharge water in the wells had risen about 60 ft., to an elevation of 65–80 ft. below the ground surface. During the eleven-day interruption the level dropped off about 20 ft. to an elevation 85–110 ft. below the ground surface. At the conclusion of the experiment, on June 17, the recharge water in the well shafts was at approximately elevation 70, the equivalent of an additional gain of from 5 to 10 ft. The standing water level at this time was estimated to be at elevation 105, or about 35 ft. lower than the level of the recharge water in the shafts. The water level was then drawn down by pumping until an elevation of 180–190 was observed on October 1. A comparison of this level with that of 210–230 for the previous year shows a net rise in the water level of approximately 30

ft. during the year. Incidentally, the quantity of well water used during 1948 was about equal to the amount used during the same period of 1947.

Conclusions

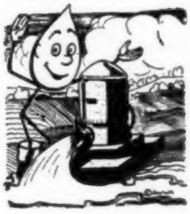
Although definite conclusions cannot be made from this experiment alone, it may safely be stated that:

1. In addition to the regular demand for consumption, it is practical to transport a portion of the overflow, as it occurs at Macopin Intake, for a distance of approximately 25 miles through existing piping to the area of the industrial wells in Newark.

2. The overflow occurs at a time of decreased consumption demands and the water temperature is then at its lowest, as desired.

3. Under existing conditions, it should prove profitable to the city to sell the overflow water as it occurs, even at a special low price for recharge water, rather than to receive no income, as at present, for the same water.

It must be remembered, however, that there might be times when overflow will not be available at Macopin Intake for recharge. When such dry periods occur, the real worth of this well recharge method will definitely be established.



Watershed Sanitation and Recreational Use

By Carl A. Hechmer

A paper presented on Oct. 22, 1948, at the Joint Meeting of the Four States and Western Pennsylvania Sections, Philadelphia, by Carl A. Hechmer, Maint. Engr., Washington Suburban San. Com., Hyattsville, Md.

THE control of reservoir watersheds has long been the subject of considerable research and study and is now recognized as an important engineering problem in the preservation of a safe and adequate water supply. Improvement in protection of the water supply, reduction in maintenance costs, erosion control and public use of the area for recreation are the main factors involved. Space will not permit the detailed discussion of the several phases of watershed control and they are therefore treated only in a general way, since it is the purpose of the author to give in detail some actual experiences involving his own work along this line.

In watershed control, the term "protection" generally means the safeguarding of the sanitary quality of the water in order to prevent gross pollution which might place too great a load on the purification plant. Sewage and industrial wastes are the principal offenders and their disposal must be constantly watched and improved.

Erosion Control

The paramount factor in watershed work, however, is erosion control. Excessive erosion on the watershed will not only impair the physical and biological quality of the water but will reduce the life of the reservoir itself, necessitating replacement at too early a date or costly dredging operations to prolong its life, a very important economic factor. If there is a choice of sites for a reservoir, consideration should be given to avoiding large erosion control expenditures which might have to be made later to effect proper maintenance.

In the early days of erosion control, the planting of trees—especially conifers and evergreens—was the only method employed, and great forests were laid out, completely covering the watershed holdings of the water department. However, as a large percentage of the watershed usually remains outside the ownership of the water department, erosion control by governmental agencies has brought other methods into play, such as pasture land, contour cultivation of farm lands, crop control and proper road drainage.

The planting of forests on watersheds provides some financial return from the sale of Christmas trees, lumber, pulp and cordwood, as the growth of the trees permits. At Newark, N.J., it is reported that afforestation has paid its own way by producing Norway spruce and red pine for Christmas trees. It is the general opinion at this time that watershed work should at

least pay for itself. Raising cattle and sheep, hay production and forest products are excellent sources of income.

Beautification of the landscape should also be given a good deal of thought. The planting of flowering shrubs and trees along firebreaks, paths, fence lines and other suitable locations will attract public attention and result in favorable comments and impressions concerning the water works and its management. Such watershed planting has been inaugurated at Norfolk, Va., and has received national recognition.

Recreational Use

Although the primary purpose of the reservoir and the control of its watershed is the production of a safe, satisfactory and adequate water supply, the recreational use of such public land should be seriously considered for the enhancement of public relations, which cannot be measured in dollars and cents alone. Some income can, however, be derived from this practice. Recreational use includes fishing, picnicking, hunting, horseback riding (using firebreaks as bridle paths), camping and, in some locations, summer cottages and bathing. The use of such areas for game preserves has also been suggested.

In July 1943 the Washington Suburban Sanitary Commission completed a dam on the Patuxent River which forms a lake 5¼ miles long and impounds 6.5 bil.gal. of water for the district. The commission owns 2,550 acres of land at this lake, of which 775 are under water. Water from this reservoir is filtered and chlorinated in modern purification plants before being delivered to the public.

The commission and its engineers are advocates of the use of watershed properties for such restricted recreational purposes as the safety of the public water supply will permit. In collaboration with and pursuant to the approval of the Maryland department of health, the commission issued regulations permitting fishing, both from shore and boats, in certain parts of the lake, using the zone principle suggested by the department of health. Although picnicking was prohibited in the original regulations, the commission later developed two areas—one at the head of the lake and the other immediately below the dam—where fireplaces, tables and sanitary facilities are provided. Because these picnic areas have proved very popular and are crowded on favorable weekends, additional sites are now being considered.

TABLE 1

Fishing Permit Revenue, 1944–47

	Number Issued			
Permit	1944	1945	1946	1947
One-day	772	1,030	3,024	2,908
Weekly	13	11	7	
Yearly	172	143	189	334
Revenue	$1,265.50	$1,246.50	$2,467.50	$3,124.00

The use of the firebreaks on the commission's property around the lake for horseback riding will be permitted as soon as they are completed. Skating, building fires, picknicking in other than the areas provided, camping, bathing or wading and the use of firearms are all prohibited, however.

The fishing season extends from July 1 to November 30, in accordance with the regulations of the Game and Inland Fish Commission of Maryland. Permits must be secured from the commission to fish in the lake, and none is issued unless the applicant has already secured a state fishing license. One-day permits cost 50¢ each and a season permit is $5.00. Weekly per-

mits were issued for several years at $1.50 but have been discontinued. Table 1, which lists the number of permits issued from 1944 to 1947, shows the increasing use of the lake by those who like to fish.

During the 1927 season there was a total of 60 boats on the lake, all privately owned. The commission expects eventually to provide boats for hire to the fishermen and to prohibit the use of private boats. The object is to exercise better control over the type of boat used and to prevent the accumulation of great numbers of boats moored at the locations selected as harbors. Can-type privies are provided at the boat harbors.

Two men are now employed to patrol the watershed, one using an automobile and boat, the other on horseback. Comparatively few violators are found in the large area covered, and it is a fact that the real sportsman, who gets the necessary permits, appreciates the recreational facilities placed at his disposal and frequently acts as a patrolman in preventing violations of the regulations, especially the sanitary rules.

Cost of Facilities

The commission has encountered no difficulty in providing these recreational facilities and will probably consider further recreational use of its lake property in the future. The economic feature must, of course, be taken into account, since it is the commission's duty to provide a water supply, not park areas; but enhancement of public relations has a substantial value.

In the author's opinion, the cost of providing recreational facilities on a public water supply watershed, if the facilities are not self-supporting (considering the cost of patrolmen necessary to enforce total prohibition of use of the land), should be paid for out of other public recreational funds. The control of the watershed and its use for recreation should, however, remain under the water department, which is responsible for the quantity and quality of the water.

Public relations and community benefits can reach a high standard under proper control consistent with the production of a safe water supply, especially in areas where other natural park facilities are limited. Authorized recreational use will prevent improper use by irresponsible people, since the general public, in appreciation for the facilities made available to it, will aid in correcting those who abuse the privileges and endanger their continuation.

Cement as a Jointing Material

Panel Discussion

A panel discussion presented on May 30, 1949, at the Annual Conference, Chicago.

Dale L. Maffitt

Gen. Mgr., Water Works, Des Moines, Iowa.

OF the several jointing materials being used for making joints for bell-and-spigot cast-iron water mains, cement is probably the least publicized. Naturally, the water works operator is interested in having pipelines built so that there will be a minimum amount of leakage, and he is also interested in the use of materials which will not cause deterioration of the pipe or aggravate electrolysis conditions.

Portland cement was patented in 1824 by Joseph Aspdin, a bricklayer of Leeds, England, who burned powdered limestone and clay in his kitchen stove. Today this cement is the basic ingredient of concrete, a combination of lime, silica, alumina, iron oxide and small amounts of other substances, to which gypsum is added in the final grinding process to regulate the setting time of the cement.

In making joints on cast-iron water mains, Portland cement is mixed only with water, to produce a crumbly, moist mixture which is placed in the bell of the pipe behind various types of packing materials. The neat cement is put into the bell in such a manner that it may be calked into place in layers, the bell being completely filled when the process is completed. A very dense mass is formed, which becomes extremely hard and waterproof after curing. It is a fact that a metallic sound is produced as the material is calked.

Portland cement was first used for joints in cast-iron water pipe between 1879 and 1889, in Redlands and San Jose, Calif., and has since been adopted in cities throughout the United States. It was reported in 1922 by cement companies in Boston, Mass., that cement joints for gas piping had been successfully used there for more than 40 years. Los Angeles, which began to employ such joints in 1894, has more than 4,000 miles of cast-iron water pipe calked with cement. It is understood that cement jointing material has been used at West Palm Beach, Fla., for a number of years, and that it was used at Miami, Fla., prior to 1941.

Des Moines Experience

Cement for making joints on cast-iron water pipe has been used in Des Moines, Iowa, since 1929. A total of 76.16 miles—12.25 miles of 6-in. pipe, 57.24 miles of 8-in. pipe and 6.67 miles of 12-in. pipe—or 17 per cent of the 452 miles of pipe in the city as of January 1, 1949, is laid with cement joints.

Local climatic conditions must, of course, be taken into consideration in the use of this type of material, and rec-

ords show that the lowest mean daily atmospheric temperature when cement joints were being made at Des Moines was 28°F. It has not been the practice to make cement joints for maintenance and repair work in winter temperatures.

It is felt that there is a definite place in the water works industry for this type of jointing material. If properly handled, it will insure a joint which, in actual tightness, will be comparable to other materials approved by the Association.

Laurance E. Goit

Chief Engr. of Water Works & Dep. Gen. Mgr., Dept of Water & Power, Los Angeles.

Cement joints have been used on cast-iron pipe in the West at least since the early nineties, and considerable experimenting was done before the calkers arrived at the technique now employed. It is reported that they started by yarning as if for a lead joint and then substituted wet cement for the lead. They also tried soaking the yarn in cement grout and filling the joint with such rings of yarn. These joints were not at all satisfactory and attempts to use cement languished for a time. It is definitely known that in 1907 joints were made successfully in Long Beach, Calif., with slightly moistened cement. Since then cast-iron joints have been constructed by the most effective technique of filling the joint space tightly with neat cement, moistened just enough to make it stick together.

Cast-iron bell-and-spigot pipe of all sizes offers the greatest and most obvious use for cement joints. Any joint that is designed for calking, however, can be made tight with cement. Steel pipe with bells formed by various processes are handled exactly like cast-iron pipe by the skilled calker. Steel sleeves for repairing leaks or joining plain pipe ends also are readily calked with cement. It must be recognized that the result is a rigid joint strong enough to break the pipe, and certain precautions must be taken both in the general laying of the pipeline and in making the individual joint. Before the joints are made, each pipe must be solidly on the trench bottom in ground that is not going to settle. If the ground has been filled or is soft and might later move, the inflexibility of cement joints will probably cause broken pipe.

In some places, there is a wide range of temperature in the water conveyed through the various seasons. Los Angeles experiences a range of nearly 35°F. Such temperature variation can cause a tension stress in the pipe wall of 7,500 psi. Although this stress, by itself, should be safe, when added to a stress resulting from a slight settlement or a beam loading on the pipe, the combination might be enough to cause failure. Pipe will frequently be quite hot in the sun when the joints are made and the temperature difference between the pipe and the coldest water might exceed 85°F.

This point which appears to be a disadvantage of cement joints is not very serious. Such failures seem to occur only when extremely long runs of cement joints are used and do not happen when a lead joint is used at intervals of about 500 ft. The author does not know of any mathematical formula to determine the maximum safe length. In the opinion of some engineers, who have used cement joints for many years, this length varies from 300 to 500 ft., while others pay no attention to the length of main that is rigidly jointed.

The hazard was recognized by engineers very early in the use of cement. In addition, predictions were made that the strain resulting from changing stresses would crumble the cement and cause serious leaks. The author has never heard of a cement joint crumbling if undisturbed for only a few hours after calking. There are, however, enough instances of unexplained cast-iron pipe breaks occurring near the end of occasional extremely cold seasons to warrant recommending that a lead or other flexible joint be used every block or equivalent distance.

Early comments about cement joints included the opinion that the insulating effect of the nonmetallic calking would result in serious electrolysis damage. The joints have a high electrical resistance, even though the pipes are solidly home in the sockets when the joints are made. This characteristic has the effect of breaking the line into short sections, each of which may have an opportunity to collect or discharge a small amount of stray current. But these small currents cannot be aggregated into a dangerously large flow to leave the pipe at one place. In fact, cement joints have been a definite help in combating stray currents.

Results of Questionnaire

The author sent a questionnaire on cement joints to a number of West Coast water works officials, from Portland, Ore., to San Diego, Calif., including both small communities and large cities. The questions and a summary of the 23 replies follow:

1. Do you regularly use cement for cast-iron pipe joints? Yes: 19; No: 4.

2. If not, what material is used for most of your joints? Lead: 1; Sulfur: 2; Steel pipe: 1.

3. Do you use any hemp or yarn in making cement joints? Yes: 9; No: 10.

4. How long have cement joints been used in your community? Average: 35 years.

5. What maximum length of main do you joint continuously with cement without a flexible or expansion joint? No limit: 10; About 500 ft.: 9.

6. What proportion of your cement joints leak when new? (All replies were less than 1 per cent and, after curing, practically none.)

TABLE 1

Cost of Cement and Lead Joints in Cast-Iron Pipe

Pipe Size *in.*	Material per Joint—*lb.*		Cost of Finished Joint—$	
	Lead	Cement	Lead	Cement
6	10	5	2.20	0.28
8	13	6	3.05	0.35
12	18	9	4.00	0.53
16	30	15	6.70	0.84
20	37	19	8.25	1.15
24	44	23	9.80	1.40
30	56	28	12.50	1.75

The common acceptance of cement joints in the West is indicated by the response to Question 1. And the tally of 19 out of 23 does not include a small company, primarily operating an irrigation system, using steel drive pipe with the valves connected by cement joints. All of those reporting use lead or other joints in filled ground or for the quick finishing of a job.

A majority make cement joints without any yarn or other packing, using straight cement. The packings employed by others are asbestos, jute, oakum and rubber. The purpose of the

packing seems to be primarily to center and steady the spigot in the bell, which can also be accomplished with temporary wedging chisels.

The length of time cement joints have been reported in use varies from 1 year to approximately 60, with half reporting over 25 years.

Anxiety about damage by thermal contraction appears to be evenly divided. The replies indicate, however, that the concern of many of those who use some lead joints is for the safety of a gate or fitting rather than the straight pipe. Consequently, lead joints are employed at practically every intersection or connection, which seems to eliminate any need for considering temperature stress.

Many say that a few joints weep a little when first put under pressure, but this phenomenon usually stops within 48 hours. If a cement joint leaks enough to make a stream, instead of dripping, it probably will not stop and might as well be done over. In Los Angeles, a pipeline is expected to be "bottle tight" and there is no tolerance for leakage.

After curing, cement joints are not injured by freezing but, of course, the pipe will burst if the freezing is great enough.

Cement joints are by far the cheapest to make. Labor and material costs were both less than for poured joints in the old days of 4¢ and 5¢ lead. In 1932 a cement joint could be made for one-fifth of the cost of a lead joint. At present, that relation is approximately one to seven. Table 1 presents rough estimates of the costs of cement and lead joints at current prices (labor—$1.82 per hour, cement—$0.80 per sack and lead—$0.15 per pound).

Quite in contrast to the costs making up the high figures for lead joints, the largest factor in the price of cement joints is labor. On a small job, it is usual for a calker to mix his own cement, tempering enough at a time for several joints but never more than can be used in an hour. On large pipe, the time required for making joints and the quantity of cement used render it economical to have a helper mixing cement for several calkers. Only one calker can work on the joints in the smaller sizes, but with pipe 20 in. and larger, two men can work opposite each other, making faster progress on the joint and keeping it balanced.

Cement is generally used neat, and there will not be any shrinkage if the quantity of water for tempering is not excessive. It should not be possible to draw any free moisture by troweling or calking the mixture. If moisture can be drawn to a surface, the cement will flow and cannot be calked to a ringing hardness. Experiments have been made with sanded mixtures but they are not economical. If the sand is not dried, its moisture content is not known, and the mixtures produced will not be uniform. The expense of handling sand is much greater than the saving of cement warrants, and the joint is not improved by its use.

The consensus is that cement joints should ordinarily be allowed to set for 16 to 24 hours before taking pressure. However, pressure has been applied on joints only eight hours old without leaks. Closing joints in a line of pipe have been made with cement, a small addition of calcium chloride being used to accelerate the set. Care must be exercised not to employ too much calcium chloride and to use the cement soon after mixing.

Check List

Cement joints in bell-and-spigot pipe, either of cast iron or steel, have proved their practicability and economy in hundreds of miles of mains laid in the last few decades. Proper techniques must be used, however. Besides the manual skill of the calker, the following points are important:

1. The trench bottom should be graded carefully to center and align the pipe properly.
2. The pipe spigot should be solidly home in the socket.
3. The pipe should be steadied in the trench by a small amount of backfill.
4. A joint should not be calked until five or six lengths of pipe have been laid beyond it.
5. The cement should be properly moistened. Laboratory tests have indicated that 16 per cent of water by weight is best.
6. Mixing must be thorough to break up all lumps.
7. The cement should be calked hard in layers. Pneumatic tools can be used on large joints.
8. Cement must not be used after any partial set.
9. After calking, the joint should be covered with moist earth or wet sacking. The cement should not be permitted to dry out.
10. Pressure should not be put on joints until they have set for sixteen hours or more. Filling the pipe with water without pressure after four hours will be beneficial.

Cement joints are not difficult to break in order to cut in a fitting or change the grade. They can be chipped out with a pneumatic hammer and a cape chisel. If the top half of a joint is pretty well cleaned out, lifting the pipe will break out the rest. This statement must not be taken to indicate that the cement shell in the joint will shatter from vibration or stresses arising from temperature changes.

The cement joint has satisfied many water system operators and can satisfy more if they are willing try it.

George W. Pracy

Supt., Water Dept., San Francisco.

The first cement joints in cast-iron water pipe in San Francisco were made in April 1917, with the author in charge of the work. The use of cement came about as a result of an article by Clark H. Shaw (1), then superintendent of the Long Beach, Calif., Water Dept.

From 1917 to 1929 cement was used in all cast-iron pipeline construction in San Francisco. In 1929, and for the next two or three years, cement-sulfur joints were employed in an effort to reduce costs. No savings were effected, but instead one 16-in. and two 12-in. pipelines laid in 1930—and later several others—were destroyed by what was evidently an expansion of the joint material. Consequently, cement was again adopted and has been the standard joint material since that time. In contract work, either lead or cement is permitted, the contractor furnishing the material and being paid the contract price per linear foot of joint. So far no contractor has used lead.

Cement has been entirely satisfactory as a jointing material. In fact, cement joints will stand vibration better than lead joints. Leaky lead joints under railroad tracks have been permanently repaired by replacing the lead with cement. Pipelines with cement joints can be lowered to a reasonable degree, and up to now all required lowering has

been accomplished without any trouble in the joints. If a leaky spot does appear in a joint, it can be repaired by chipping it out and calking in lead wool. The best detailed description of how to make a cement joint is given by Shaw in the article previously mentioned (1), and additional information on this subject may be found in a paper by the present author (2) published in 1920.

Thirty years' experience with cement joints has been so satisfactory on the Pacific Coast that no doubt is ever expressed about the use of that material. Cement joints, of course, must set about 24 hours before the pressure is put on the line. Lead is still used in joints when the water must be turned on immediately after the job has been completed. There has been some question of the effect of cold temperatures on cement joints. As the pipe must be laid deep enough to prevent freezing, no temperature troubles should arise.

References

1. SHAW, CLARK H. Cement Joints for for Cast-Iron Pipe. Trans. A.S.C.E., **83**:277 (1919–20).
2. PRACY, GEORGE W. Cement Joints for Cast-Iron Water Pipe. Jour. A.W. W.A., **7**:436 (July 1920).

C. F. Wertz

Resident Engr., Dept. of Water and Sewers, Miami, Fla.

At this date the Miami, Fla., Dept. of Water and Sewers does not use cement for joints in cast-iron pipe, but from 1932 to 1942 practically all joints were made with this material. Prior to 1932 most of the joints had been made with lead. The author has not been able to learn from old records or employees why cement was first used (in October 1931) in the placing of approximately 10,000 ft. of 24-in. cast-iron feeder main. The records now indicate that there are about 75 miles of cement joint mains in the system, as shown in Table 2. In 1942 this figure represented 14 per cent of all pipe in the system.

Until 1941 the distribution system was owned and operated by the Miami Water Co., while the low-pressure transmission mains were owned by the city. When the city bought the distribution system from the Miami Water Co. late in 1940, and the present Dept.

TABLE 2

Cement Joint Mains in Miami

Pipe Size *in.*	Cement Joint Mains *ft.*
4	36,144
6	155,792
8	84,191
10	14,663
12	24,000
16	13,178
18	280
20	18,772
24	10,641
30	10,932
36	30,470
48	174

of Water and Sewers was created, practically the entire personnel of the Distribution Div. of the company was transferred to the new department. The pipe-laying crews were then making cement joints.

In June 1942, with common labor already getting scarce, it was found necessary to lay a new 24-in. high-pressure line, approximately 2,600 ft. long, and the author suggested that a sulfur-compound joint material be used. The pipe-laying crews were skeptical, as well as the Distribution Div. superintendent,

but finally Hydro-tite * was employed. This material made such a tight line and cut down the amount of labor per joint so much that, since that time, practically all pipe—totaling approximately 190 miles—has been laid with either Hydro-tite or Bond-o. † By January 1949 the 75 miles of cement joint lines represented only 10 per cent of the total.

Usually cement joints were made with neat cement and water in a very dry mix and were calked in two layers. On a 36-in. transmission main, laid in 1936 and totaling approximately 30,000 ft., a 1 : 1 mixture of sand and cement was used. The Distribution Div. superintendent estimates that it took two men about 30 minutes to make a cement joint in a 24-in. pipe.

The pressures in the 36-in. and the two 42-in. transmission mains average 20 psi., while, in the distribution system leaving the high-pressure pumping stations, they average 80 psi. or more. From 1941 to 1948 the average daily consumption has increased from 23.5 to 40.4 mgd., and the pressures leaving the high-pressure stations have had to be increased 10–15 psi. In the author's opinion, these increases are the major reason for the gradual rise in the percentage of unaccounted-for water from 7.8 per cent in 1942 to 12.7 per cent in 1948. These figures include line losses, hydrant flushing, fire fighting and so forth.

In Miami, temperature changes amount to little or nothing in pipe buried with 2 ft. or more of cover. Winter or summer the water inside the pipes does not vary over 2° from 78°F. Breaks in mains are few, and the leak survey crew reports that most leaks are due to thread failure on service taps.

Miami is located on a soft limestone ridge paralleling the ocean. Trenching is simple and trench bottoms usually provide good solid foundations for pipe.

Miami Beach

Miami Beach, across Biscayne Bay from Miami, uses lead exclusively for cast-iron pipe joints. This fact is mentioned because it stresses the point that cement joints are not desirable under all conditions of soil and trenching. Miami Beach was originally a narrow sand spit with large mangrove swamp areas on the bay side. The greater portion of the city today is on sand fill over mangrove swamp muck; pipe trenching is difficult, on account of the relatively insecure bottom. Under such conditions, lead joints provide a rather flexible line as compared to the very rigid one made with cement. When settlement causes leaks, recalking of the lead joint usually suffices. The same settling in a cement joint line would mean cracked bells or pipe and would create a major repair job in trenches that are wet 85 per cent of the time.

West Palm Beach Water Co.

West Palm Beach and Palm Beach, Fla., are supplied with water by the West Palm Beach Water Co., which uses cement joints for cast-iron pipe. Plant Supt. J. P. Simmons states that the system contains a total of 213 miles of mains, of which 34 per cent, or 73 miles, has cement joints. There are also about 55 miles of asbestos-cement pipe. Unaccounted-for water records are poor, but the information available indicates that the water loss is approximately 15 per cent. Joints are made with neat cement and water, and one

* Made by Hydraulic Development Corp., New York.

† A product of Northrop & Co., Inc., Spring Valley, N.Y.

man can make about ten joints a day in 12-in. pipe. There is one poor cement joint line in the system, a 24-in. main, approximately 2.5 miles long, laid about 15 years ago by a contractor using a 1:1 mixture of cement and sand. Today a good many of the joints on this line are reinforced with bell clamps. No sulfur compounds have ever been used in this system.

NOTE

For those interested, the following directions for making cement joints are quoted from the forthcoming A.W.W.A. "Tentative Standard Specifications for the Installation of Cast-Iron Water Mains":

Cement. All cement shall be of approved brand acceptable to the engineer and shall comply with the current specifications of the American Society for Testing Materials.

Proportions of cement and water. One quart of cement shall be thoroughly mixed with about ¼ pint of water. The mixture shall be such that, when tightly compressed by hand into a ball which is then broken into two pieces, the break shall be clean. If the hand is water-stained, the mixture is too wet. If there is evidence of crumbling in the break, the mixture is too dry. The cement mixture shall ring with a metallic sound while being calked.

Cause for rejection. No cement shall be used after having been wet more than one hour or after its initial set.

Calking cement joints. Starting at the bottom the joint space shall be filled with the cement mixture and the mixture calked. The remaining joint space shall then be refilled and calked until the joint is practically flush with the face of the bell. The mixture shall be thoroughly compacted to make a watertight joint without overstraining the bell.

Trench water and initial set. No water shall be allowed to touch the joint until the initial set has taken place.

Joints kept moist until set. Cement joints shall be covered immediately with damp burlap, or other material approved by the engineer, for the proper time to insure complete hydration. In cold weather care shall be taken to prevent freezing of the cement mixture before and after the joint is made.

Time interval before filling pipe. Pipe laid with cement joints shall not be filled with water until a lapse of twelve hours after the last joint in any valved section has been made. . . .

Construction and Traffic Safety Measures

A Compilation

THE following pages contain a compilation of five statements from California sources, dealing with street construction and safety policy, which are applicable to water utility operations. The subjects covered are:

1. Reducing surface traffic interference from street excavations
2. California trench construction safety orders
3. General safety policy
4. Water department safety rules
5. Safe operation of motor vehicles

These statements are taken from the following booklets:

1. *Surface Traffic Interference,* a manual published in 1949, prepared by the Surface Traffic Interference Subcommittee of the Substructure Committee of Los Angeles. The members of the subcommittee include representatives of the telephone company, water and power department, police department, bureau of sanitation, and contractors. This booklet was designed to help meet the problems resulting from the rapid increase in motor vehicles and traffic flow in Los Angeles by minimizing the interfering effect of excavation and maintenance work. Handsomely and profusely illustrated with diagrams and photographs giving point to the text, the booklet is being used as subject material for a considerable number of in-service training programs among the utilities and large contractors of the Los Angeles area.

2. *Trench Construction Safety Orders,* issued on April 20, 1945, by the Div. of Industrial Safety, California Dept. of Industrial Relations. In his article on the San Diego accident prevention program (May 1949 JOURNAL, Vol. 41, p. 397), A. George Fish refers to the Div. of Industrial Safety regulations as "San Diego's bible," and remarks that each foreman in the water, sewer and street divisions is supplied with a copy for reference and use on the job. This and other booklets, containing safety rules and orders on such subjects as air pressure tanks, boilers and electrical equipment, are for sale by the Printing Div., Documents Section, 11th & O Sts., Sacramento 14, Calif.

3. *Your Job,* issued in August 1946 by the Long Beach, Calif., Water Dept. and distributed to its employees as part of the department's accident prevention program. The booklet is the outcome of efforts by the Employee's Safety Committee—a body composed of nonsupervisory employees of the Long Beach Water Dept. selected by their coworkers—to combine a projected orientation booklet with a set of safety rules and regulations. The last page of the booklet consists of a detachable receipt form which employees sign to acknowledge that they have received and read the booklet and are pledged to observe its recommendations. The receipts are kept in the individual employee's personnel file.

Reducing Surface Traffic Interference From Street Excavations *

Good public relations are generally the result of public opinion, and all companies, small or large, desire that these relations be maintained at a high level. The various utility companies' public relations are with people—they are the public. These people develop their opinions of a utility by what they see the crews doing—repair work, street excavations, working in open manholes, handling and parking of trucks, etc. There are a multitude of operations such as these which are necessary, day-to-day jobs. But many of these may offend when done carelessly or thoughtlessly. The company is likely to be judged efficient or not efficient by what the people see, as well as the service they receive. It will be the *little* things that are done or are not done that will largely determine public opinion.

Good public reactions are desired by all who must, from time to time, do work in the highway which will interfere with vehicle traffic. Two important things are needed to get and hold a favorable public opinion—actions and words. The right actions must come first and then words as to how the problems and difficulties are being met—perhaps by signs, news items, etc.

With this as a goal for those engaged in various public service activities, particular attention of both foremen and workers should be directed into the common channel of a reasonable minimum surface traffic interference. Some of the important work operations to be considered are briefly discussed in the following paragraphs.

* Reprinted from "Surface Traffic Interference," Substructure Committee of Los Angeles (1945).

Contact With Police

Where police intersection traffic control is in operation, contact should be made with the officer on duty, giving a brief explanation of the work to be done and the time period involved, and obtaining any suggestions he may have regarding the traffic flow. The required notification to the Police Parking and Intersection Control Div. should also be made.

Open Excavations

1. Open excavations are a hazard; protect motorists, pedestrians, and children especially, against injury at all times.

2. They should not be kept open longer than necessary, consistent with work being done and traffic flow.

3. At intersections the job should be planned in such a way that only a portion of the crossing is closed at any one time, the portion open depending on traffic flow.

4. If part of a street is completely blocked by excavation work for a time, arrange to guide traffic around the obstruction in a safe manner.

Barricades

Consideration should be given to:

1. Providing protection to both the worker and the public with minimum interference to the public.

2. Rearranging as conditions permit to provide less interference with traffic flow.

3. Providing a sufficient amount to protect both motorist and pedestrians—rope, wooden fence, wooden horse, rubber cones, etc.

Investigation has disclosed many cases where, had thoughtful consideration been given, barricades would have been placed a few feet from where they were placed, and another lane of traffic permitted to flow. (*See* Fig. 1.)

Spoil Bank

The spoil bank may offer more traffic interference than necessary by spreading over too large a portion of the street, or the dirt may become a hazard in wet weather.

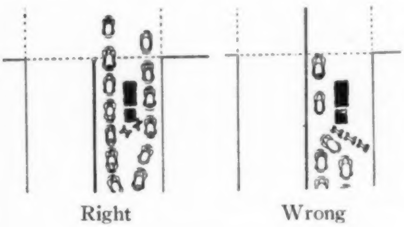


Fig. 1. Placement of Barricades

1. It should be held from spreading by the use of "toe" board or "bins" on those streets where the spreading would unduly interfere with traffic movement.
2. At street intersections it should be hauled away when it will not be used. This will provide the least interference with intersection traffic.
3. When the excavation is in the outer lane, confine the excavation and spoil within the outer lane by use of bin construction or toe boards to prevent spoil from spreading into and blocking another traffic lane. Place rail guard on the traffic side of the trench. (*See* Fig. 2.)
4. When the excavation is in the curb lane, place the spoil on the curb side,

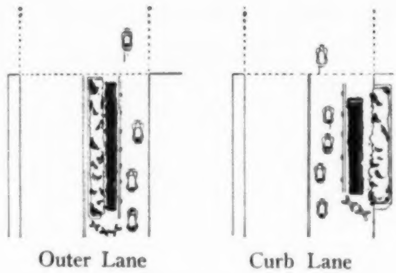


Fig. 2. Placing Spoil Banks

after first covering the gutter for a free flow of drainage. Boxing of the spoil on the sidewalk side is essential. Place a rail guard on the traffic side of the trench. (*See* Fig. 2.)

Work Equipment

The inconsiderate placing of pumps, mixers, digging machines, tool boxes, necessary trucks and other equipment frequently blocks, unnecessarily, a traffic lane. Care should be exercised as to:

1. Its use at street intersections; thoughtful consideration is necessary if traffic interference is to be at a minimum.
2. The need for the equipment; frequently it may be placed in the lane of traffic already blocked by the excavation or open manhole. It should be kept out of open traffic lanes. (*See* Fig. 3.)

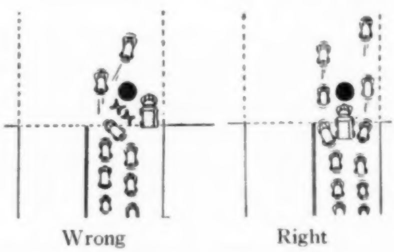


Fig. 3. Parking Work Truck

Time Work Performed

Traffic interference is greatest on busy streets in the periods 7:00 A.M. to 9:30 A.M. and 4:00 P.M. to 6:00 P.M., and all work operations should be considered with this fact in mind. Every reasonable effort should be made to program the work to be done in such a manner that traffic interference is at a minimum during these periods, consistent, of course, with the nature of the required work.

Temporary and Permanent Resurfacing

Trenches left with tamped dirt as a surfacing material are not satisfactory for motor vehicle travel. The use of premix or "black top," as it is known in the field, is of considerable value as a temporary resurfacing material. The surface remains relatively firm and when replaced in a reasonable period of time with permanent street paving offers a satisfactory temporary street excavation repair. Its use is increasing, where traffic is involved, as the result of experiences with it. Its use is required by ordinance in Los Angeles and many other cities. Proper follow-up to see that the temporary surfacing is replaced with permanent paving is very important.

Steel Plates

The proper and reasonable use of steel plates will materially reduce traffic interference. Consideration should be given to their use:

1. At street intersections to reduce traffic interference by an open trench, when no work is in progress.

2. Across an open trench in driveways and on walks, where required to provide safe passage for vehicles or pedestrians, when work is being performed.

3. When no work is being done at noon, nights, Saturdays or Sundays.

The edges of the plates should be held by premix firmly tamped, as a hazard is often created when the approach is made of dirt. Plates should have angle cleats on the bottom to prevent any possible displacement.

Motor Vehicles

Company work vehicles, when not necessary at the point of work, especially on heavy traffic flow streets, should be placed on side streets or in some location where they will not interfere with traffic flow. Employee-owned vehicles should not be parked on busy streets near the point of work merely for convenience of easy access. In most cases, it results in traffic interference, and some other parking location should be found.

Parking

A universal belief exists that drivers of city vehicles, utility vehicles, etc., may park such vehicles wherever they think necessary, with little or no regard to parking regulations. The traffic regulations under The Los Angeles Municipal Code exempt only police and fire vehicles, and such public utility vehicles as are *"qualified as an authorized emergency vehicle."* The ordinance also exempts city or public utility vehicles when parked or standing in restricted zones only when *necessarily in use* for construction or repair work.

Only a small percentage of vehicles belonging to the city, utilities or contractors are exemptible by the ordinance in day-to-day operations.

Working Between Safety Zones and Curbs

From time to time certain work operations are necessary between an established safety zone and the curb. The width of the space is relatively small, and on busy streets the blocking of this area, together with the safety zone, materially interferes with traffic. Careful consideration should be given and plans should be made to block this area for the shortest possible period.

Multiple Street Operations

An excavation or work in an open manhole by one utility or city department will interfere with vehicle traffic. There have been many occasions, however, when work operations by two or more of these groups were going on at the same time on opposite sides of a street in a single block, resulting in serious and often unnecessary traffic interference. Where such a condition will exist if an additional crew starts operation, the work should not be started until the situation has been given consideration by proper representatives of the groups involved and the police.

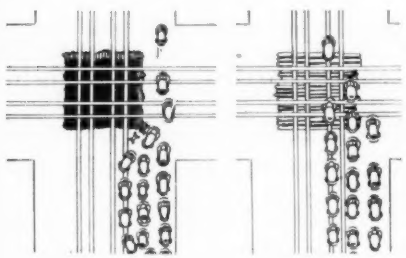


Fig. 4. Repairs at Railway Crossing

Railway Crossings

Necessary repair work at railway crossings in busy intersections may seriously interfere with motor vehicle traffic, unless steps are taken to reduce the interference to a minimum.

The use of old ties over which oiled gravel has been spread may often speed up traffic around and over the excavations made. (*See* Fig. 4.)

Traffic Lanes

The creation of traffic lanes has proved an aid to traffic movement, and to some extent has reduced traffic hazards. In view of this, consideration should be given to the following:

1. Never force traffic to the left of the centerline of the street except when no other means of movement is reasonably available. If forcing traffic over the center line is necessary, police permission to do so is mandatory. Cooperation of the Police Dept., Parking and Intersection Control Div., and the Street Traffic Engineer should be solicited. Careful guiding of the traffic around the obstruction by means of rubber cones, directional barriers, etc., is necessary in any case.

2. Keep adjacent lanes open when one lane is automatically blocked by an excavation or open manhole.

3. Lawful parking in restricted zones: a vehicle parked at a curb on a busy street blocks one lane that could be available for traffic movement.

4. Where other public utility operations, such as street cars, are or may be affected, they should be notified.

It seems evident, from the information and facts that have been developed, that very material improvements can readily be made in reducing surface traffic interference by thoughtful consideration on the part of those in charge of work being done on the streets. When such consideration is given, it should

not be difficult to obtain a better balance between the necessary work in the street and interference with traffic movement.

The traffic police have the responsibility for the safe movement of traffic at the reasonable legal speeds. Their job is often made more difficult by failure to give consideration to the motor vehicle traffic interfered with by the utility operations. The fact that traffic delays and hazards are reduced by careful planning of operations makes the effort well worth while.

Trench Construction Safety Orders *

Sec. 8101—Permits for Variations From These Orders

When the Division finds that, under such conditions as shall be specified, a variation from the terms of a Safety Order will not impair the safety of employees which would otherwise be secured by compliance with the terms of the said Order, the Division, upon written application, after investigation and such hearing as the Division may direct, may make and enter its Order permitting such variation from the terms of the said Safety Order in a place of employment, upon such conditions as it may specify and upon the provision and use of such safety measures and appliances as shall, in the judgment of the said Division, secure the safety of employees. A record of such Order shall be conspicuously posted at the place of employment and shall be open to the public.

Noncompliance with the conditions specified in an Order permitting a variation shall automatically suspend such order as long as the noncompliance exists.

Upon receipt of a complaint that a variation imperils the safety of employees which would otherwise be secured by compliance with the terms of its Safety Orders, the Division, after notice to the complainant and to employer and after hearing, may continue in force, suspend, revoke or modify its order permitting the variation or may continue in force, suspend, revoke or modify the conditions specified in such Order.

Where death or serious injury at the place of employment appears to be attributable to a variation from the terms of the Safety Order, the Division may forthwith set aside any variation previously granted. Notice of such action shall be conspicuously posted at the place of employment and shall be open to the public.

No declaration, act or omission of the Division or of its representatives, other than a written Order authorizing a variation as permitted under this Order, shall be deemed to exempt, either wholly or in part, expressly or impliedly, any employer or place of employment from full compliance with the terms of any Safety Order.

Sec. 8102—Definitions

(a) Trench means any excavation, other than railroad or highway cuts,

* Reprinted from "Trench Construction Safety Orders," California Div. of Industrial Safety (1945).

in which the greatest depth is equal to or greater than the width.

(b) Sheeting means all planking or metal, or both, used to support the sides of trenches.

(c) Sheet-piling means all planking or metal, or both, used to exclude running material.

NOTE.—It may be tongue and grooved, splined planking, ship-lapped planking or standard metal sheet-piling.

(d) Shoring and bracing means the supporting elements of sheeting and sheet-piling.

(e) Stringers are the horizontal, longitudinal components of shoring and bracing.

Sec. 8105—Materials for Sheeting

All materials used for sheeting and sheet-piling shall be in good condition, and all timbers used shall be sound, straight, free from cracks, shakes and large or loose knots and of the required dimensions throughout.

Sec. 8110—Use of Sheet-piling

(a) Where running material is encountered, the sides of all trenches 4 ft. or more in depth shall be secured by the use of sheet-piling and suitable braces, as defined in these orders.

(b) Where trench is between 4 ft. and 7 ft. in depth, wooden sheet-piling shall be not less than 2 in. in thickness. Where trench is over 7 ft. in depth, wooden sheet-piling shall be not less than 3 in. in thickness.

Sec. 8111—Shoring and Bracing

(a) The sides of all trenches in hard, compact material * which are 5 ft. or more in depth and over 8 ft. in length shall be securely held by shoring and bracing. If the unit tunnel method is used, the length of earth left in place between the separate unit trenches shall be not less than one-half the depth of the trench.

Whenever the unit tunnel method is used in soils such as sand, loose gravel or any material which is liable to move or cave, the trenches and tunnels shall be adequately shored and braced or otherwise retained as may be necessary to prevent them from caving.

(b) All trenches of over 8 ft. in length and 5 ft. or more in depth in hard, compact material * shall be braced at intervals not exceeding 8 ft. with 2-in. by 6-in. planks, or heavier material, placed vertically in the trench opposite each other against the walls. These braces shall, if possible, extend to the bottom of the trench; otherwise as low as possible to clear the top of pipe, sewer, conduit or other material to be placed in the bottom of the trench.

(c) The braces in trenches shall be supported by screw jacks or by timbers placed normal to both braces, cleated and rigidly screwed or wedged. The timbers shall be not less than those given in the following table:

Width of Trench	*Size of Timbers*
1 ft.–3 ft., incl.	4 × 4 in.
3 ft.–6 ft., incl.	4 × 6 in.
6 ft.–8 ft., incl.	6 × 6 in.

(d) The number of horizontal strut braces, either screw jacks or timbers, required for each pair of vertical braces shall be determined by the number of zones of 4 ft. each into which the depth

* The Industrial Accident Commission interprets hard, compact material to mean all soils in trenches other than running, saturated, filled or unstable. Section 8110 (a) requires the use of sheet-piling in running material. Section 8112 requires the sheeting and bracing of the sides in all trenches in saturated, filled or unstable soils or materials.

of trench may be divided. One horizontal brace shall be required for each of these zones. Trenches, the depth of which cannot be divided equally into these standard zones, shall have an extra horizontal brace supplied for the short remaining zone if such zone is greater in length than one-half the 4-ft. unit. In no case, however, shall horizontal braces be spaced greater than 5 ft. center to center.

(e) The bracing and shoring of trenches must be carried along with the excavation and must in no case be omitted except that where a mechanical digger is used the shoring shall be placed to within 10 ft. of the lower end of the boom.

(f) Stringers shall be not less in strength than 2-in. by 6-in. clear timber.

Sec. 8112—Sheeting and Bracing in Saturated Ground

Trenches in saturated, filled or unstable material (not running material) shall be sheeted to an extent adequate to hold the material in place. The supporting elements of this sheeting shall be in accordance with the requirements for shoring and bracing as given in these orders.

Sec. 8113—Placing of Excavated Material

Excavated material shall not be placed nearer than 1 ft. to the edge of the trench.

Sec. 8114—Ladders in Trenches

All trenches 5 ft. or more in depth shall be supplied with at least one ladder for each 200 ft. in length or fraction thereof, which ladder shall extend from the bottom of the trench to at least 2 ft. above the top. Ladders shall be constructed with two sides of at least $1\frac{1}{2}$-in. by 3-in. timber or its equivalent in strength, and the rungs shall be placed 1 ft. on centers and securely fastened to the sides.

Statement of Safety Policy *

The California Industrial Accident Commission has the power, jurisdiction and supervision over every employment and place of employment in this state, which is necessary adequately to enforce and administer all laws and lawful orders requiring such employment and place of employment to be safe, and requiring the protection of the life and safety of every employee in such employment or place of employment.

By reason of these powers, and in order that the water department safety activities shall conform to the prescribed standards, the Safety Orders of the State of California Industrial Accident Commission [*see* p. 666] are therefore the safety policy of the Long Beach Water Dept.

The following are a few general and specific rules that will help supervisors and employees alike in preventing accidents.

Responsibility of Foreman and Supervisor

The foreman is the operating executive of management. His responsibility

* Reprinted from "Your Job," Water Dept., Long Beach, Calif. (1946).

is second to none. One of his prime responsibilities is safety. The foreman is responsible for the carrying out of the water department safety policy.

The foreman is responsible for the enforcement of safety rules and the instruction of all employees under his charge in safe practices. The foreman is responsible for the prompt and correct reporting of accidents. The foreman is responsible for the condition of and inspection of all tools, equipment, material and safety and health appliances.

Accident Prevention

Experience has proved that the observance of safety rules has prevented many industrial accidents. No set of rules however elaborate can be written that can take the place of attention to the job and the use of everyday common sense in the prevention of accidents. These rules are given without comment, to point out a large number of pitfalls that the average workman will find in his daily work.

The employee who disregards them is a menace to himself as well as to his fellow workers. Frequent reading of these rules will make you aware of the everyday hazards and respect for them may contribute to a much longer and certainly a much happier life.

Your cooperation is vitally necessary in this safety program. Thoughtlessness and inattention on your part will offset the good work of all others.

The California Industrial Accident Commission is interested in whether or not you follow the safety rules. The important matter of workmen's compensation enters the picture if you are injured. The state labor code says:

"Where the injury is caused by the serious and willful misconduct of the injured employee, the compensation otherwise recoverable therefor shall be reduced one half."

Forgetting the rules can cost you money because in past cases the term "willful misconduct" has been held to mean failure to observe reasonably enforced safety rules or neglect in using safety devices. *There is no such thing as an unavoidable accident.*

You are responsible to your neighbor for his safety as well as your own. Therefore, it is important that at all times you obey the safety laws of the state of California, the safety rules of nature and the safety rules of the water department.

Water Department Safety Rules *

1. Obey the instructions of your foreman. If you do not understand the work laid out for you, ask for instructions, which will be given immediately.

2. Immediately report all injuries, no matter how small, to your supervisor. Failure to do so may result in a denial of compensation pay.

3. Warning signs must be obeyed.

4. If there is any doubt whatsoever as to safe procedure, ask your supervisor.

5. Horseplay and practical joking are dangerous and will not be tolerated.

* Reprinted from "Your Job," Water Dept., Long Beach, Calif. (1946).

6. Every ladder used must be properly and securely placed and free of defects.

7. Projecting nails are dangerous and should be removed.

8. Electrical repairs and adjustments and changes in any electrical equipment shall be made by the electrician.

9. Report to your supervisor any unsafe condition whenever noted. He is responsible for correcting it or having it corrected.

10. Tools and materials must not be left in elevated positions where there is a likelihood of their falling or being knocked off.

11. Do not use barrel heads, crates or boxes for working platforms.

12. Do not wear finger rings, jewelry, loose clothing or neckties when working around moving machinery.

13. No person shall be permitted to distract an employee who is operating machinery or equipment.

14. Persons spilling oil or grease on the floor must wipe it up immediately.

15. Lift with your legs, not your back. Get assistance when the load is too heavy for one man.

16. Approved goggles or face shields shall be worn on any job where there is danger of flying particles, and without exception in the following operations: grinding, chipping or scaling; handling molten metals, acids or chemicals; riveting or machining rough cuts; cleaning with compressed air; and when dust or flying particles are present.

17. Gloves shall not be worn around machines that are moving but should be worn when necessary to protect the hands against sharp objects and at all times when welding or burning. Approved rubber gloves shall be worn when handling acids and chemicals.

18. Employees working at tasks where there is material of considerable weight to be handled should wear approved safety shoes. Shoes with perforated uppers, moccasins, sandals or "sneakers" shall not be worn at any time.

19. An approved respirator shall be worn when spray painting or when exposed to vapors, fumes or dust.

20. No rule can be written to cover the piling of all types of material. Common sense is the best guide. Material shall be placed with first regard to safety. Small parts and scrap shall be placed in suitable containers. Waste material shall be promptly removed.

21. When handling tools and equipment, always inspect them before starting work. Turn in defective tools for good ones and promptly report any defective equipment or machinery.

22. Do not attempt to climb in and out of excavations on the braces or timbers. Use ladders.

23. Safety hats shall be worn by all employees working under conditions where there is danger of falling tools, material or objects.

24. Intoxication, signs of it, or possession of liquor will not be tolerated.

25. Do not look at the direct light of an arc weld.

26. Never attempt to operate machines that you know nothing about.

27. Good housekeeping is an important part of your job. Keep all machinery and passageways clear of loose material. Keep walks clear of tripping or stumbling hazards.

28. All tools, equipment, guards and safety appliances are to be inspected by a foreman at least once each month. Improper equipment is to be removed from use and a report made to the division head.

29. Employees shall not ride on running boards or fenders or cab of trucks.

30. Employees shall not ride on loads of pipe, dollies or material on trucks.

31. Employees shall not get off, or on, moving vehicles.

32. Whenever you are not sure about the method of doing a job safely and correctly, see your foreman. Ask how to do a job and avoid injury.

33. Report to your foreman at once any unsafe practices or accident hazards which you may see or which are called to your attention.

34. The leaving of file drawers and desk drawers open is a dangerous practice and will not be tolerated.

35. Use the proper tools and equipment. Do not substitute your hands for the proper wrenches, vises or clamps.

36. Use the guards provided. Remove guards only when the foreman authorizes it. Make sure all guards are in place before the machinery or equipment is set in motion.

37. Specific safety rules regarding cranes:

a. Crane operators must have a clear view and must not move a load without receiving a proper signal from an authorized person.

b. Avoid overloading cranes and chain or cable slings and never ride a load or hook.

c. Never take hold of a rope or cable near the block or sheaves, as the fingers can be drawn into the block very quickly.

d. Always allow 6 ft. or more clearance between a crane and wires, guy wires or other structures.

e. Operators must not carry or move loads over the heads of workmen or others.

f. Employees must not pass under a crane load.

g. Operating signals for cranes shall follow an approved standard; they shall be manual, never verbal. The crane operator shall recognize signals from only one man who is supervising the lift.

h. The only exception to this rule is that an emergency stop signal given by any person shall be instantly obeyed.

Safe Operation of Motor Vehicles *

General

1. Every employee whose duties require him to operate a motor vehicle must thoroughly familiarize himself with the provisions of the California Vehicle Code and city and county traffic ordinances and must obey these provisions.

2. Every driver must have, and keep in his immediate possession, a driver's license. Employees classified as truck drivers must have a chauffeur's license. When the license expires, a renewal must be applied for at once.

3. Department and division heads, designating personnel as drivers and operators, will be responsible for the safe, efficient and economical operation of all equipment under their direction and must see that drivers and operators are instructed in and comply with these rules. In no case will a person in au-

* Reprinted from "Your Job," Water Dept., Long Beach, Calif. (1946).

thority direct a driver or operator to continue the use of any piece of equipment which is damaged, when such use might be unsafe.

4. Drivers and operators of department equipment are responsible to their department or division head for the completion of any assignment. The equipment which is in their charge must be maintained in the best possible condition. In order to accomplish this, the shop foreman will notify supervisors, foremen and drivers of the day and hour that each car or truck is to be worked on and will arrange substitute equipment as may be required.

a. A daily shop inspection schedule has been set up and, so far as is possible, will be maintained. The cooperation of all drivers is requested in maintaining this schedule and in reporting repairs that are needed on equipment, or trouble as it may occur from day to day.

b. All cars in the Public Utilities Building will come in every 1,000 miles for inspection and servicing. They will be in the garage 24 hours.

5. Drivers and operators of department equipment shall have due regard for the safety of persons and property:

a. Observe all traffic rules and ordinances.

b. Assume no special privileges because they drive department vehicles; and operate only on official business.

c. No operator of department vehicles shall use or have in his possession any alcoholic beverage while on duty.

Operation of Department Vehicles

Courtesy. Courteous habits will make the rest of these rules easy to follow. Practice courtesy in your personal contacts, with other drivers on the road and with the public.

Speed limits. Section 510 of the California Vehicle Code reads: "No person shall drive a vehicle upon a highway at a speed greater than is reasonable or prudent having due regard for the traffic on, and the surface of, the highway, and in no event at a speed which endangers the safety of persons or property."

Constant speed. Operators shall drive their vehicles in such a manner that constant speed will be maintained as closely as possible, avoiding quick accelerations and decelerations.

Hand or mechanical signals. Any signal of intention to turn shall be given continuously during the last 50 ft. traveled by the vehicle before turning.

1. Method of giving signals (hand or mechanical): *left turn—hand and arm extended straight out; right turn—hand and arm extended upward; stop or slowing—hand and arm extended downward.*

Hand signals shall be clear and visible to approaching traffic.

2. No driver shall change from one traffic lane to another until it is safe to do so. Remember, the driver on your right rear cannot see your hand signal.

Parking. Vehicles must be parked in accordance with city ordinances or state laws, and precautions shall be taken to prevent theft.

1. No department vehicle shall be left unattended with its motor running.

2. When, due to work requirements, breakdown or accident, it becomes necessary to park in a roadway, sufficient precautions shall be taken to warn oncoming traffic of the existing hazard, and at a distance sufficient to prevent an accident.

3. If a roadway is blocked at night by department vehicles, the driver shall place warning lights at a safe distance

from the work, accident or breakdown to prevent an accident.

4. In no case must this first warning signal be less than 100 ft. from the hazard.

5. When parking or deparking, the operator must make certain that he can do so in safety.

6. Deparking shall be done only when oncoming traffic permits and with appropriate hand or mechanical signals.

7. If, when deparking, clear vision is obstructed the driver shall not move his equipment unless an assistant on the ground signals that it is safe to do so.

Backing equipment. Whenever it is necessary to back any motorized equipment, the duty of the operator shall be as follows:

1. If operating with a helper, or where men are available, it is the operator's sole responsibility to secure a guard at the rear of such equipment, who shall keep the area of operation clear and give proper warning to the operator.

2. If no men or other means to secure a guard are available, it shall be the operator's sole responsibility to exercise every reasonable precaution and care in keeping the area of operation clear of obstruction and interference.

Care of Department Vehicles

General. The shops are responsible for repairs to vehicles; the operator is in turn responsible to the shops for the care of vehicles while in his possession.

Inspection. Each morning before starting, and at least once during the day, operators of department vehicles shall thoroughly inspect their equipment for: [1] fuel level; [2] tire condition and inflation; [3] battery, ignition, horn and windshield wiper; [4] head and tail lights, also stoplights; and [5] broken or defective windshield, and rear-vision mirror.

Operation. All operators shall operate department vehicles as though they were a personal investment.

1. *Brakes.* Report needed repairs immediately.

a. Slow vehicle before applying brakes.

b. Do not apply brakes suddenly on wet surfaces.

c. Allow the motor to hold the vehicle back by using lower speeds.

d. On steep hills shift into the required speed before starting down and use the same speed to go down that is required to go up.

e. Intermittent application of brakes wears the lining and drum. Application should be gradual and with only sufficient force to accomplish the desired result.

2. *Loading.* Distribute the load evenly.

a. Do not overload equipment. Check with the shop for maximum loading.

b. Secure the load to prevent shifting in transit.

c. Projections over the side are not permitted, except when hauling heavy equipment and after inspection by the foreman.

d. Projections over the tailboard shall be properly flagged with a 16-in.-square red cloth or two red lights if at night, the latter to be visible for 500 ft. under normal atmospheric conditions.

e. No projecting material shall be hauled on dump trucks.

f. Limit of height is 14 ft. 6 in.

g. No high loads shall be permitted closer than 6 ft. to high-voltage wires.

3. *Cleanliness.* Keep the cab and running gear clean.

a. Allow no debris, mud or sand to collect in the cab.

b. Have the vehicle greased at regular intervals, the maximum interval being 1,000 miles.

Reporting. Each operator shall carry with him a bad-order report, and upon the discovery of any defect, shall fill out the report and leave it with the shop foreman. If roadside emergency repairs are necessary, call the service yard, describe the trouble, give the equipment number and correct location; then remain with the equipment until assistance arrives.

Accident Prevention

Throughout the foregoing, nearly every rule has been founded on safe operation. There are a few specific rules, however, that will assist the driver in preventing accidents both in traffic and on the job.

Operators shall drive in such a manner that they are prepared at all times for any eventuality.

1. Select the route best suited for the job and one that will not pass through congested locations.

2. Permit no one, either on the street or in the vehicle, to distract you while driving.

3. Assume a position behind the wheel that permits freedom of action and clearness of vision and prevents fatigue.

4. Watch traffic from all angles.

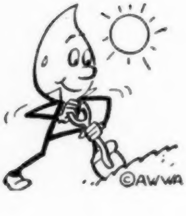
5. Let the other driver have the right of way even if it isn't his.

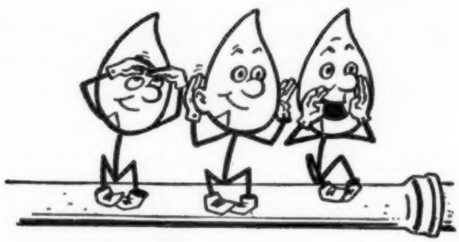
6. When it is necessary to enter a highway or boulevard from a driveway or side street, remember that approaching vehicles have the right of way and may be traveling many feet while your vehicle travels 20 ft.

7. When entering an alley or driveway from the street, the burden of safety is on the driver making such an entry.

8. Intersections: Remember, you have no right of way when driving department equipment. Remember, a collision occurring at an intersection usually is the fault of both drivers involved.

9. Keep enough distance between your vehicle and the one in front to give an ample safety factor: two car lengths at 20 mph. and four car lengths at 40 mph.





Percolation and Runoff

So only 1,967 registered, so must we eat our earlier words (*see* June P&R, p. 1) merely because 34 more of those present didn't get around to the registration line? No, we're sticking by our May muse and congratulating ourself on the unbloodiness of our projected neck. What with a new registration record established, some 263 above last year's 1,704, and with new evidences of Association vitality sticking out all over, as its membership hit a total of 7,547, we can well reiterate our estimate of "unparalleled success" and look forward to a new year of growth and accomplishment.*

And if all that sounds a bit on the defensive, it needn't, for the Chicago Conference more than lived up to expectations. Beginning with a Sunday run on the registration line and on the 134 booths of manufacturers' exhibits, the program sped through a jam-packed week of interest, information and amusement.

Regarded as the top technical treat by registrants was the Wednesday afternoon session at which A. P. Black reported on fluoridation policy; K. F. Maxcy, on recent research on the transmission of poliomyelitis; and A. D. Weston led a panel discussion on water supply quality. Not far behind in attendance, however, were a number of other sessions, led by the Monday afternoon and Wednesday morning general discussions of water works practice and ethics.

Beginning with the Memorial Day President's Reception and Dance, the new look social program made a big hit. The Tuesday night function, which combined entertainment and honors, evoked a new high in applause, for 1949 Honorary Members Thomas Amiss, Henry Berry and M'Kean Maffitt, for Diven Medalist Harry Faber, for Goodell Prizewinner Laurie Leedom, for 22 new Fuller Awardees and for the sonorous men's chorus which serenaded the host of A.W.W.A.'ers gathered to do honor to their leading lights. As for the Hayseed Hullabaloo, to say "a wonderful time was had by all" would be to do injustice to the most successful mixer at

* For a full dose of "Conference Statistics," see p. 22.

(*Continued on page 2*)

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which members ever let down their hair. So when almost 800 were on hand for the Annual Dinner and Dance, it was a fitting climax to a full week of entertainment and endeavor. Eating sumptuously, enjoying the between-course songs of Joe Wafer and John Gill, artfully accompanied by Grace Stuart's pianoing, the assemblage built up to an ovation for swan-songster Linn Enslow and inauguree A. P. Black. And during the program which followed dessert and preceded the dancing, it was M. B. Cunningham of the Southwest Section, Laurence Daniel of the Cuban Section and H. C. Medbery of the California Section who shared the honors, laying claim, respectively, to the Hill Cup, the Henshaw Cup and the Old Oaken Bucket.

These, of course, were only the highlights of the Big Week in the A.W.W.A. year. Behind the scenes, committees spent many hours of work and discussion, the Board of Directors labored through its midyear deliberations, host Illinois Section members were ever busy keeping the program at peak operation, and exhibitors' booths were in a constant hum of activity. And as it grows, A.W.W.A.'s annual conference grows ever more important to its members, more and more defying adequate description. As a matter of fact, you'd better be there next year to make the 70th Annual Conference an even greater success.

And anent Chicago, one of A. P. Black's first presidential actions, in his inaugural address, was to bring greeting to his audience from a fellow Floridian, Emiel A. Croll, senior Association member, who joined A.W.W.A. in September 1893. Having basked in the Florida sun at Orlando since his retirement in 1926, Mr. Croll submits the adjoining snapshot in evidence that Dr. Black knows whereof he exuberates.

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Howard T. Critchlow, until recently chief engineer for the Division of Water Policy and Supply of New Jersey's State Department of Conservation, has been appointed its director by Gov. Alfred E. Driscoll. The department itself has been reorganized as the Department of Conservation and Economic Development. Critchlow, who has been active in state water supply matters since 1917, will retain direct supervision over the engineering activities of his division.

Harry N. Lendall, professor of municipal and sanitary engineering and chairman of the department of civil engineering at Rutgers Univ., New Brunswick, N.J., has retired from both posts. He has been on the school's faculty for 37 years.

Water words are making a bigger and bigger splash in the nation's press these days and we're lapping them up with an unquenchable thirst for approbation. It wasn't until last May, however, that the industry gained major league status in the public relations game, and then it was the inspired play of the Saginaw, Mich., team which carried the water supply story to the very fount of publicity.

Quite understandably proud of its new water system, the Saginaw citizenry felt that more than a merely local celebration, such as its three-day "Water Festival," was called for on so auspicious an occasion. Thus, they sent a hundred gallons of their new brew to titillate Congressional palates, and Michigan's Representative Fred Crawford—a Saginaw son, himself—arranged to have it served in the House and Senate restaurants on May 13. But even earlier than that, on May 7, the columns of the Detroit *Free Press* featured a picture of four Michigan congressmen quaffing the immodestly labeled "World's Best Water," gungadined to Washington by a group of bottle-toting Saginaw students. With a "water queen" to pour out the first drink, a full-blown festival at home (for a description of which see the spread in *Life* magazine, issue of June 13, 1949) and some convincing lip-smacking by the nation's legislators, there is little question but that the Saginaw supply got the *full* treatment.

Stuntish though it may seem, this is unquestionably the type of publicity that can best make a first impression in the layman's take-it-for-grantedness. That a water supply is more than water, that a water supply doesn't just happen, that a good water supply is deserving of public appreciation seem simple enough concepts, but the fact is that even they remain generally unrealized. And beyond that, the confusion is still greater. Consider, for instance, this sentence from an editorial on "Ohio Water Supply" in the May 6 issue of the Cleveland *Plain Dealer:* "To those who live beside the lake or one of the larger rivers, the supply of this most indispensable of na-

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tural resources presents only a mechanical problem." And remember that Cincinnati is in Ohio.

Here, then, is to better as well as bigger splashes!

One of those better splashes, by the way, appeared recently in the pages of the New York *World Telegram,* where, under the title "How Dry I Am," Frederick C. Othman devoted his column of May 2 to a good, if hair-raising, description of the perils and thirsts involved in operating his private water works well system to supply his McLean, Va., home. In polishing off his story with a good plug for the dependability of the public water supplies which serve his "lucky" urban readers, Othman thus has rendered us a highly readable hunk of good publicity.

And speaking of appreciation, the shoe will be on the other foot next year in Newark, N.J., where the Revenue and Finance Director recently announced, in predicting a higher 1950 tax rate, that one factor causing it will be the "abandonment of the recent policy of bolstering the budget by seizure of water department surpluses." All things come . . .

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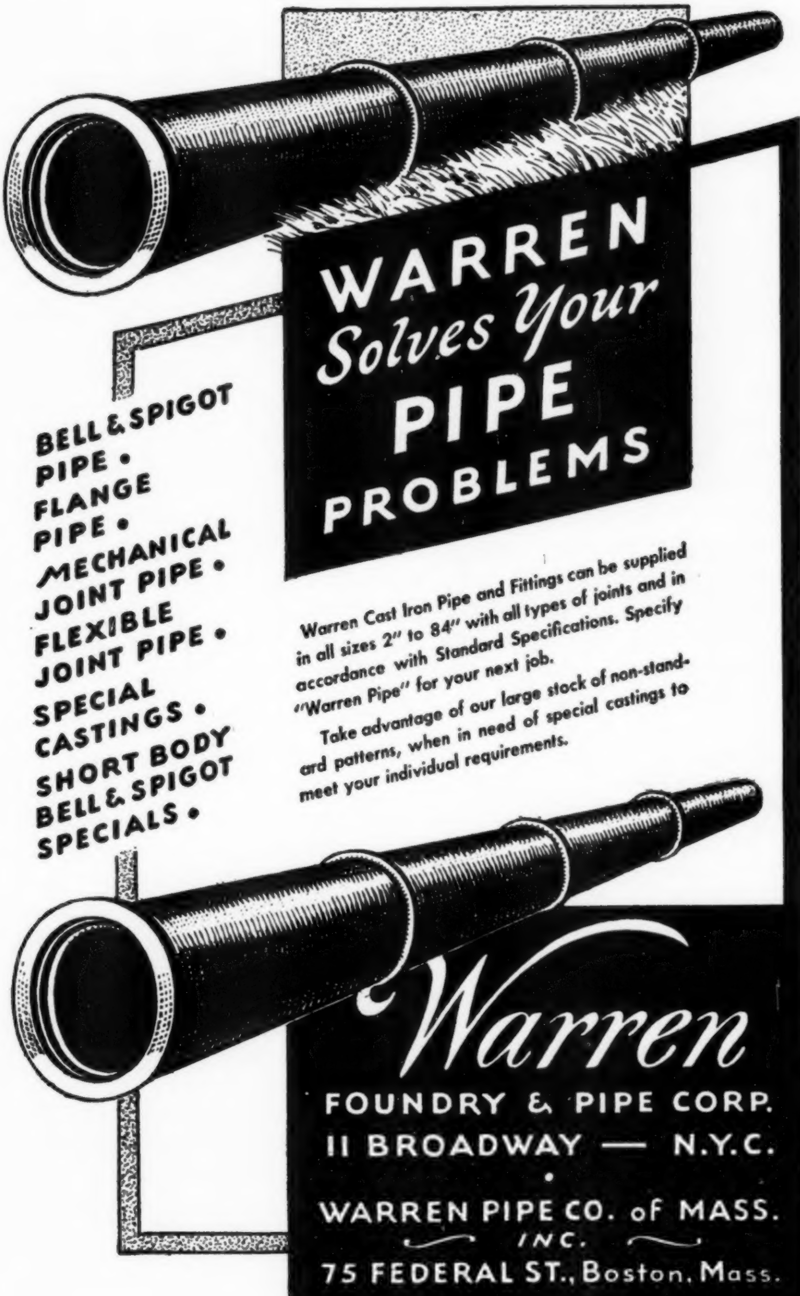
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David B. Lee, chief sanitary engineer of the Florida Board of Health, has been appointed advisor to the United States delegation to the World Health Organization. As the post obliged him to leave for Rome on May 30, he was obliged to forego his share of the panel discussion on "Water Supply Quality" held at the Chicago Conference two days later.

A United Nations Scientific Conference on the Conservation and Utilization of Resources, authorized by the UN Economic and Social Council, will be held at Lake Success, New York, from August 17 to September 6. Invited to participate in the discussions, which will feature exchange of ideas, experiences and information, are organizations and experts representative of the member nations and of interested groups. All invitations are being issued by the Secretary-General. Over 450 scientists and technical experts in fields which affect utilization and conservation of natural resources have agreed to prepare papers for the conference. Among the A.W.W.A. members who will discuss various aspects of water supply are Abel Wolman, Professor of Sanitary Engineering of Johns Hopkins Univ., Baltimore ("Utilization of Surface, Underground and Sea Water"); Carl G. Paulsen, Chief Hydraulic Engineer, Water Resources Branch, U.S. Geological Survey ("Current Concepts in Appraisal of Water Resources"); and Ernest W. Steel, Consulting Engineer, Instituto Nacional de Obras Sanitarias, Caracas, Venezuela ("Control and Utilization of Polluted Waters").

Arthur S. Tuttle, variously engineer, PWA administrator, inventor and consultant, died May 19, 1949, at the age of 84 in Brooklyn Hospital, Brooklyn, N.Y. He had worked for the Brooklyn water works and later for New York City, after the consolidation of the five boroughs. In 1921 he became the city's chief engineer, and, after his retirement in 1928, he was retained as consultant. In 1933 he joined the P.W.A. as engineer, becoming state director for New York in 1935. Two years later he left to enter private practice as a consultant. Among the many accomplishments of his career were a study of the potential water resources of the Hawaiian Islands, the invention of a water meter for large mains, and the invention of an air release valve for distribution systems.

Paul D. Frame, head of the Ulrich Chemical Co., Inc., since 1933, died on May 15, 1949, while on a fishing trip on the Canadian-Minnesota border. During World War II he had served as an officer attached to the Technical Training Group in Sioux Falls, S.D.

Herbert C. Schmitt, assistant superintendent of filtration of the Milwaukee, Wis., Water Dept., died on May 24 at the age of 58. He had been with the department for more than 20 years.

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"Hydrology," the ninth volume of a series of reports on Physics of the Earth issued under the auspices of the Division of Physical Sciences of the National Research Council, has just been reprinted in a less expensive edition. The book, edited by Oscar E. Meinzer and originally published in 1942, covers all phases of the hydrologic cycle and contains much material on ground and surface waters, precipitation, snow and ice, runoff and droughts. Copies may be obtained from Dover Publications, Inc., 1780 Broadway, New York 19, N.Y., for $4.95 if prepaid.

Ferrous plugs, bushings and locknuts are the subject of a new American Standard (ASA B16.14–1949) in the preparation of which the A.W.W.A. has cooperated. Copies are available, at 40¢ each, from the American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N.Y., which acted as publishing sponsor.

Brass or bronze screwed fittings (250 lb.) have likewise been standardized in ASA B16.17–1949, which may be obtained from the same source at a cost of 35¢ each. Both documents were approved by the American Standards Assn. on April 6, 1949.

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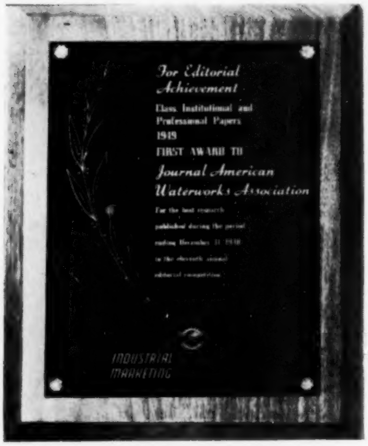


The Case of the Swallowed Canary has been solved, and the cat duly let out of the bag. All of which is to say that the mystery of the JOURNAL editorial smile these past few weeks can now be revealed.

Sharp-eyed sleuths will already have deciphered the following inscription on the evidence presented:

For Editorial Achievement
Class, Institutional and Professional Papers, 1949.

First Award to: Journal American Water Works Association
For the best research published during the period ending December 31, 1948, in the eleventh annual editorial competition conducted by *Industrial Marketing.*

Background of the case is as follows: Each year *Industrial Marketing* magazine, leading trade paper in the business publishing field, sponsors a contest among business papers of three different classifications, offering prizes for the best series of articles, the best single article, the best single issue, the best graphic presentation and the best published research. It was in this last category that the JOURNAL entered its "Survey of Operating Data for Water Works in 1945," published in the February 1948 issue. And it was this 96-page data-crammed article which brought home a first prize, presented at the annual convention of the National Industrial Advertisers Association in Buffalo, N.Y., on June 15.

Incidentally, the treasured hunk of inscribed bronze will greet visitors to A.W.W.A. headquarters in its reception room. And for those who missed the prizewinning article, reprints are available at 50 cents per copy.

(*Continued on page 14*)

(*Continued from page 12*)

We just ain't linguagenic, and we know it, but the solution offered by the editors of *Southwest Water Works Journal* may well be worse than our present problem. Editorializing in their May issue, our Southwestern friends cite the popularity of such nicknames as "Coke" and "Monkey-Ward," deplore the terrible tonguetwistingness of "American Water Works Association" and suggest in its stead a rapid pronunciation of "A(no period)W (no period)W(no period)A(still no period)." Pointing out that the resulting "ah-wa" sounds like the Spanish word *"aqua"* [*"agua,"* that is], which means "water," the editors indicate its obvious appropriateness and want the Association thereby henceforth to be "friendlily known."

As hinted above, we're in perfect agreement with the diagnosis. It's the cure that worries us. Aware that the "ah-wa" pronunciation of *agua* is used and understood, we agree too that the definitive tie-in is absolutely unbeatable. Thus we are given pause only by its auditory connotations. Perhaps we have listened to too many *Amos and Andy* programs, but "ah-wa" (however spelled) has come, to us, to mean trouble, disappointment, disillusionment. And the thought of being tagged with such a doleful sound is anything but enticing. A speech, for instance, as liberally sprinkled

(*Continued on page 16*)

(Continued from page 14)

with references to A.W.W.A. as we would like it to be, might well take on the tenor of a lamentation. An announcement concerning the Association could properly be made only by a town crier. And if Willing Water were really called the AWWA Kid, he'd surely soon take on the character of a tear drop.

Not to be entirely destructive, we ought to express a preference for "ay-way," spelled the same, though sacrificing the definition. Then at least when we answered the telephone, people wouldn't feel obliged to be sympathetic. Look AWWA, Dixieland!

We hailed Colombia last May (P&R p. 8) for successfully rejuvenating an age-old technique of drought dispellment. And if the flood that followed this application of supplication was almost as damaging as the dry spell it ended, that was obviously not the fault of the prayer, but of the prayers, who must have overasked. At any rate, with the "puissance of prayer" thus proved, the parched populace of a droughty Europe took hopeful note and immediately instituted its own regimen of entreaty.

Only a few days later, the *United Press* office in Lisbon was able to report a heavy rainfall throughout Portugal for the first time in many months. Then from the *Associated Press* in Rome we learned that rain, breaking the greatest drought in 30 years, immediately followed a Sunday suppliance in the city's more than 400 churches. That this fall too—totaling almost 50 inches in a week—engendered a damaging flood speaks only more strongly of the efficaciousness of the technique. And finally, *Associated Press* intelligence from Wisborough Green, England, recounts the tale of the bishop of Chichester, who led his congregation to the banks of the river Arun to pray for rain and then had to hustle it back inside his church to avoid the downpour.

A coincidence of coincidences or not, we're beginning to doubt our dry-ice.

Alfred H. Fletcher, director of the New York City Bureau of Sanitary Engineering has been appointed director of New Jersey's Bureau of Environmental Sanitation. The bureau is in the reorganized State Health Department and the appointment is effective July 16. Fletcher had previously been a sanitary engineer with the Rockefeller Foundation and had been assigned to the U.S. Public Health Service Station at Memphis, Tenn. In addition he has taught sanitary engineering at Johns Hopkins Univ. and is currently teaching at Columbia Univ.

The District Office for U.S. Geological Survey ground water investigations in the New York-New England area has been moved from the Post Office Bldg., Jamaica, N.Y., to 22 Old Country Rd., Mineola, N.Y.

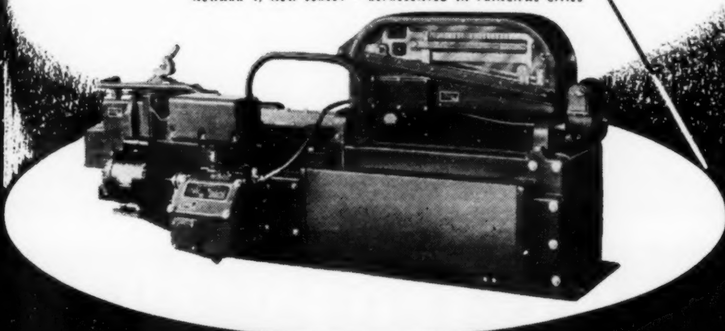
(Continued on page 18)

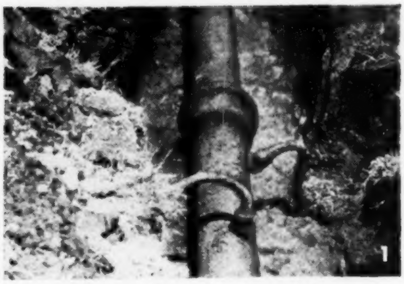
(Continued from page 16)

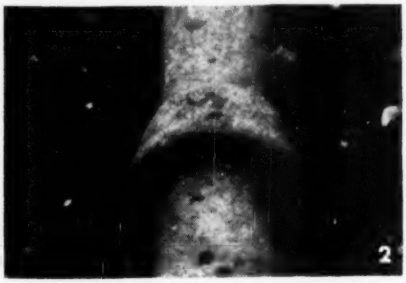
Science grows more frustrating and scientists more obfuscating with every passing hour. Not only in the glamourous garden of atomic energy, but right in our own backyard. Only the other day we turned dutifully to our copy of *Science,* official publication of the American Association for the Advancement of Science, and were thrilled by the title: "Discontinuities in Properties of Water as a Function of Temperature." Did we find a story of hot-weather distribution system breaks? Not on your life! Something, instead, about previously unobserved inflection points in the temperature-density curve, which would seem to hint that water has hitherto been allowed to travel around under false pretenses because the basic data required to plot a proper curve have been playing hard to get. In another issue of the same publication, we pricked up our eyes to find, under the title "Quantitative Relations in the Physiological Constitutions of Mammals," a discussion of the interrelationships between water intake and body weight of some fourteen mammals, ranging from the lowly Peromyscus to the mighty elephant. But struggle as we would, we could find real basis for neither amazement nor action. "The interrelations found," we were told, "imply quantitative orderliness" among a host of mammalian characteristics, and this was proved by the development, with the aid of a simple heterogonic equation, of a nomograph on which were presented some 34 correlatives in the mammals studied. Wincing under the weight of all this erudition, we could grasp at only one logical thought: "Steer quite clear of correlatives; remember what trouble simple relatives have already caused."

Despite this recondite runaround, however, we continue to explore the esoteric enigmas of science, for in science, we are sure, lies the clue to the future, and the future, we are equally sure, bears looking into. Thus, when a faint glimmer of almost understanding lights up our burdened brain cell, we are sometimes hard put to contain ourself and almost as relieved as disappointed to find it a mere flash in the pan. At any rate, our present difficulty involves discovering the future when it is already past or, at the very best, present. Thus our heart went out not long ago to one S. D. Antipin, Soviet biologist, whose discovery that the world's ills are traceable directly to man's evolution to two legs dumped him unceremoniously and probably on all fours in the Kremlin's doghouse. If Antipin's hallowing of horizontality is not entirely new, our full appreciation of it is. How, for instance, could we be two-fisted if we were yet four-footed? So we're inclined to discredit the official Soviet discreditation of Antipin on the grounds that he was a White Russian soldier ignoramus nonbiologist whose magnum opus was entitled "Rebuilding human organism on a horizontal principle, on the harmfulness of walking on the hind legs and placing rabbits in a vertical position so as to lengthen their fur."

One reads, but understandeth not! We write . . .







(1) This 101-year-old cast iron water main is serving Frederick, Maryland.

(2) Still in use after 118 years of service in the water supply system of St. Louis, Mo.

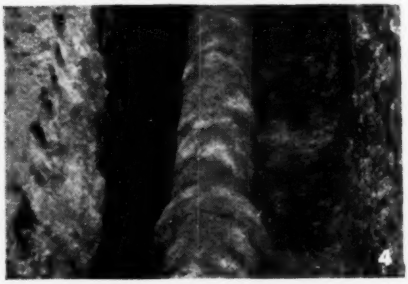
(3) This water main, installed 117 years ago, is still serving Richmond, Va.

(4) Lancaster, Pa. laid this cast iron water main 105 years ago. It is still serving.

(5) One of several cast iron water mains that have been serving New York City for more than a century.

(6) America's oldest cast iron water main, now in its 132nd year of service in Philadelphia.

(7) This cast iron water main has been serving Boston for 120 years.



CAST IRON PIPE

CONFERENCE STATISTICS

(*Story on p. 1*)

Chicago Registration by Days

Day	Men	Ladies	Total
Sunday, May 29	628	210	838
Monday, May 30	584	141	725
Tuesday, May 31	231	20	251
Wednesday, June 1	96	3	99
Thursday, June 2	54	—	54
TOTALS	**1,593**	**374**	**1,967**

Geographical Distribution of Registrants

UNITED STATES and TERRITORIES

Alabama	28
Alaska	1
Arizona	1
Arkansas	9
California	77
Colorado	15
Connecticut	4
Delaware	3
Dist. Columbia	15
Florida	31
Georgia	22
Hawaii	4
Illinois	402
Indiana	71
Iowa	65
Kansas	20
Kentucky	29
Louisiana	24
Maine	5
Maryland	24
Massachusetts	23
Michigan	66
Minnesota	36
Mississippi	10
Missouri	93
Nebraska	12
New Hampshire	2
New Jersey	90
New York	175
North Carolina	13
North Dakota	7
Ohio	100
Okahoma	22
Oregon	2
Pennsylvania	140
Puerto Rico	2
Rhode Island	13
South Carolina	13
South Dakota	6
Tennessee	47
Texas	35
Utah	1
Virginia	23
Washington	10
West Virginia	10
Wisconsin	103
Wyoming	2

CANADA, CUBA and FOREIGN

Australia	1
Canada	39
Cuba	6
Egypt	1
Great Britain	3
Indonesia	1
Mexico	6
Venezuela	3
TOTAL	**1,967**

Comparative Registration Totals—1940–1949

Year	Place	Men	Ladies	Total
1949	Chicago	1,593	374	1,967
1948	Atlantic City	1,348	356	1,704
1947	San Francisco	1,115	431	1,546
1946	St. Louis	1,303	214	1,517
1944	Milwaukee	1,185	171	1,356
1943	Cleveland	973	158	1,131
1942	Chicago	1,198	240	1,438
1941	Toronto	1,136	309	1,445
1940	Kansas City	1,265	202	1,467

Winners of Section Awards—1949

Henshaw Cup	Hill Cup	Old Oaken Bucket
Cuban 88.9%	**Southwest .... 45.6 pt.**	**California 798**

PROFESSIONAL SERVICES

Membership Changes

NEW MEMBERS

Applications received May 1 to 31, 1949

Ammons, Delton E., Dist. Supt., Southern California Water Co., 214 E. Colden Ave., Los Angeles 3, Calif. (Apr. '49) *M*

Andersen, C. O., *see* Laramie, City of

Area, Oscar J., Secy.-Mgr., Fairview County Water Dist., Costa Mesa, Calif. (Apr. '49) *M*

Bagenstos, Earl, *see* Water Tower Paint & Repair Co.

Bakman, Dick, General Partner, Bakman Homesites Water Utility Co., Route 2, Box 139, Fresno, Calif. (Apr. '49) *M*

Beach, Wallace, *see* Brantford, Township of

Beique, Jean C., City Mgr. & Engr., Grand'Mere, Que. (Apr. '49)

Beltzner, Roy E., Supt., Water & Street Depts., San Jacinto, Calif. (Apr. '49)

Bennett, G. Vernon, Chairman, Water & Power Committee, City Council, City Hall, Los Angeles 12, Calif. (Apr. '49) *R*

Bleasdale, Plin D., Supt., Div. of Water Supply, Roan Anderson Co., 140 California Ave., Oak Ridge, Tenn. (Apr. '49)

Bolls, Edward E., Jr., Civ. Engr., Black & Veatch, 4706 Broadway, Kansas City 2, Mo. (Apr. '49)

Bowers, Eugene, Research Chemist, Metropolitan Water Dist. of Southern California, Box 38, La Verne, Calif. (Apr. '49) *P*

(Continued on page 30)

(*Continued from page 28*)

Brantford, Township of, Wallace Beach, Water Works Supt., 73 Charlotte St., Brantford, Ont. (Corp. M. Apr. '49)

Brockie, Thomas A., Contracting Engr., Consolidated Western Steel Corp., Box 2015 Terminal Annex, Los Angeles 54, Calif. (Apr. '49) *M*

Brown, C. W., Pacific Northwest Repr., Inertol Co., Inc., 1238 N.W. Glisan St., Portland 9, Ore. (Apr. '49) *M*

Brown, Donald L., City Mgr., Wakefield, Mich. (Apr. '49)

Buehler, Albert, Prin. Asst. Supt. of Pumping Station Operation & Maint., Bureau of Water Supply, Baltimore, Md. (Apr. '49)

Burnett, Graydon E., Head, Paint Lab., Bureau of Reclamation, Denver Federal Center, Denver, Colo. (Apr. '49) *M*

Burr, Donald F., Asst. Supt., Lindsay Strathmore Irrigation Dist., 920 Parkside Pl., Lindsay, Calif. (Apr. '49) *M*

Casey, I. J., Jr., Town Engr., Municipal Bldg., Irvington 11, N.J. (Apr. '49)

Century Geophysical Corp., M. E. Morrow, Exec. Vice-Pres., 1333 N. Utica Ave., Tulsa, Okla. (Corp. M. Apr. '49) *R*

Chalus M., Julio A., Civ. Engr., Public Works, Calle 8 No. 563, Vedado, Havana, Cuba (Apr. '49)

Chandler, E. E., Supt., Water Dept., Williamson, W.Va. (Apr. '49)

Chew, William Walton, Water Supt., Lower Penns-Neck Township, 43 N. Broad St., Pennsgrove, N.J. (Apr. '49)

Coleman, Paul Hayes, Job Engr., Bechtel Corp., 62—1st St., San Francisco, Calif. (Apr. '49) *P*

Collar, Louis H., Owner, The Louis H. & K. J. Collar Co., 1913 Tauromee Ave., Kansas City, Kan. (Apr. '49)

Connell, Harry H., Chief Engr., Wilson & Co., Engrs., 737 Custer St., Salina, Kan. (Apr. '49)

Cornell, Holly A., Partner, Cornell, Howland, Hayes & Merryfield, Cons. Engrs., 212 Rennie Bldg., Corvallis, Ore. (Apr. '49) *PR*

Coxon, G. Douglas, Plant Supt., Water Works Dept., Corp. of Ottawa, Transportation Bldg., Ottawa, Ont. (Apr. '49)

Craner, Carl, Chief Engr., Wildwood Water Dept., Wildwood Pumping Station, Rio Grande, N.J. (Apr. '49)

Dahle, Elkins William, Jr. Asst. Supt. of Maint., Water Dept., Bureau of Water Supply, 2809 Westfield Ave., Baltimore 14, Md. (Apr. '49) *M*

Dalton, Charles P., Sr. Asst. Supt., Bureau of Water Supply, Municipal Bldg., Baltimore, Md. (Apr. '49) *MR*

Dann, George H., Gen. Supt. & Engr., Philadelphia Suburban Water Co., 762 Lancaster Ave., Bryn Mawr, Pa. (Apr. '49)

Davoust, Norbert J., Sr. San.Engr., South Dist. Filtration Plant, 3300 E. Cheltenham Pl., Chicago 49, Ill. (Apr. '49) *P*

DeHoff, Ronald L., Tech. Director, Trico Mfg. Co., 1622 M & W Tower Bldg., Dallas, Tex. (Apr. '49) *P*

Denham, Henry Lane, City Administrator, Pittsburg, Calif. (Apr. '49) *M*

Dickinson, Willis F., Contracting Engr., Consolidated Western Steel Corp., Box 2015 Terminal Annex, Los Angeles 54, Calif. (Apr. '49) *R*

Dixon, Charles J., Supt. of Water, 419 Richmond Rd., Kenilworth, Ill. (Apr. '49)

Dyer, Clyde E., *see* Knoxville Power Co.

Eisenhauer, E. E., *see* Saskatchewan Provincial Govt.

Farebrother, Ernest J., Supt., Water Works Dept., Niagara Falls, Ont. (Apr. '49)

Faust, George K., City Engr., 221 W. Main St., Chanute, Kan. (Apr. '49)

Fetherston, Florence (Miss), Vice-Pres., Felton Water Co., Felton, Calif. (Apr. '49)

Fisher, Donald E., Salesman, L. C. Pensinger & Son, 3510 Metropolitan Ave., Kansas City, Kan. (Apr. '49)

Foss, Elsworth, *see* La Habra, City of

Fox, John, Operator, Filtration Plant, 419 Richmond Rd., Kenilworth, Ill. (Apr. '49)

Frichett, R. S., *see* Pure Carbonic, Inc.

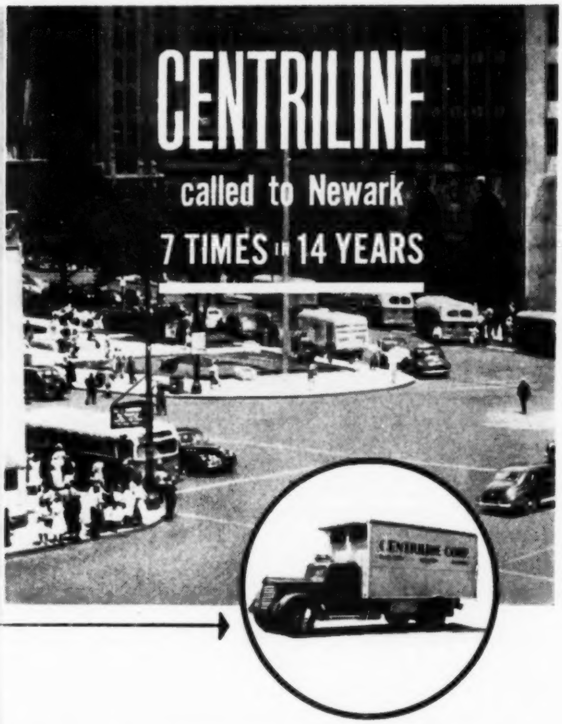
Frost, W. F., *see* Watkins Glen Water Dept.

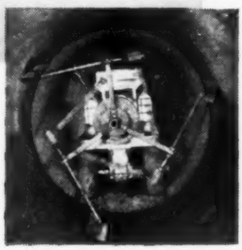
Goble, L. B., Mgr., Water Dept., 3rd & Vine Sts., North Platte, Neb. (Apr. '49)

Goodwin, H. M., Field Mgr., Water Tower Paint & Repair Co., Clear Lake, Iowa (Apr. '49)

(*Continued on page 32*)

where performance counts . . . count on Centriline





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(*Continued from page 30*)

Graybeal, Earl, Gen. Mgr., Kentucky Water Service Co., Somerset, Ky. (Apr. '49)

Greenland, J. A., Dist. Mgr., De Laval Steam Turbine Co., 706—3rd Ave., Seattle 4, Wash. (Apr. '49)

Griggs, Marion A., Chief Pumping Plant Operator, McNary Damsite, Corps of Engrs., Umatilla, Ore. (Apr. '49) *MP*

Halff, Albert H., Student, Johns Hopkins Univ., School of San. Eng., Baltimore, Md. (Apr. '49)

Hamilton, J. R., Supt., Water Works, Kingman, Kan. (Apr. '49)

Hawkins, Ernest D., Technician, Water Eng. Dept., Utilities Board, 1935 McClung Ave., Knoxville, Tenn. (Apr. '49)

Hebbard, Ralph L., Engr., Operations & Maint., Dist. of Columbia Water Dept., Bryant Pumping Station, Washington 1, D.C. (Apr. '49)

Hermann, Joseph T., Supt., Water Works, Town of Lake, Milwaukee 11, Wis. (Apr. '49) *MP*

Higgenbottom, Everett H., Supt., Water Works, Fairfield, Iowa (Apr. '49)

Hogan, Ruth G. (Miss), Jr. Asst. Supt. of Services & Records, Bureau of Water Supply, Municipal Bldg., Baltimore, Md. (Apr. '49) *M*

Hollowell, William I., Prin. Foreman, Constr. & Maint., Munic. Eng. Div., The Panama Canal, Box 135, Diablo Heights, Canal Zone (Apr. '49)

Holmes, J. C., Water Supervisor, Buhl, Idaho (Apr. '49) *P*

Howe, John B., Sales Repr., The Dorr Co., 221 N. La Salle St., Chicago, Ill. (Apr. '49)

James, E. Colin, Secy., White Rock Water Works Co., Ltd., Box 25, White Rock, B.C. (Apr. '49)

Johnson, W. E., Pres., White Rock Water Works Co., Ltd., Box 25, White Rock, B.C. (Apr. '49)

Jones, James R., Geologist, U.S. Geological Survey, University Station, Grand Forks, N.D. (Apr. '49)

Jungmann, E. J., Partner, Jungmann Bros. Drilling Co., 1009 Huntoon, Topeka, Kan. (Apr. '49)

Kelly, R. A., Supt., Water Works, City Utilities Com., Corbin, Ky. (Apr. '49)

Kennedy, Richard R., Cons. Engr., Eng. Office of Clyde C. Kennedy, 604 Mission St., San Francisco, Calif. (Apr. '49)

Killian, Lawrence J., Filtration Supt., Water Works, 2703 Hartmetz Ave., Evansville 12, Ind. (Apr. '49) *P*

Knoxville Power Co., Clyde E. Dyer, Supt., Alcoa, Blount County, Tenn. (Corp. M. July '48) *MP*

La Habra, City of, Water Dept., Elsworth Foss, City Hall, 201 E. Erna Ave., La Habra, Calif. (Corp. M. Apr. '49)

Laramie, City of, Water Dept., C. O. Andersen, Asst. City Engr., Laramie, Wyo. (Corp. M. Apr. '49) *M*

Leach, Donald A., Dist. Sales Mgr. & Director, Chicago Bridge & Iron Co., 332 S. Michigan Ave., Chicago 4, Ill. (Apr. '49)

Leaverton, Robert L., Asst. Sr. Engr., Bureau of Water Supply, Municipal Bldg., Baltimore, Md. (Apr. '49)

Lindner, Truett E., Asst. Supt., Pumping Plant, Utilities Board, Knoxville, Tenn. (Apr. '49)

Long, Carl H., Town Engr., Munic. Water Plant, Fries, Va. (Apr. '49)

Loop, H. Enzo, Comr. of Public Improvements, Shelton, Wash. (Apr. '49) *M*

Lupien, Leo, City Mgr., City Hall, Louiseville, Que. (Apr. '49)

Marshall, Sidney R., City Supervisor, Bardstown, Ky. (Apr. '49)

Maywood, Village of, William Thomas, Water Dept., 125 S. 5th Ave., Maywood, Ill. (Corp. M. Apr. '49)

McNutt, Robert J., City Engr. & Supt. of Water System, Hillsdale, Mich. (Apr. '49)

Middleton, W. G., Supt., Public Service Com., City Hall, Yazoo City, Miss. (Apr. '49) *MR*

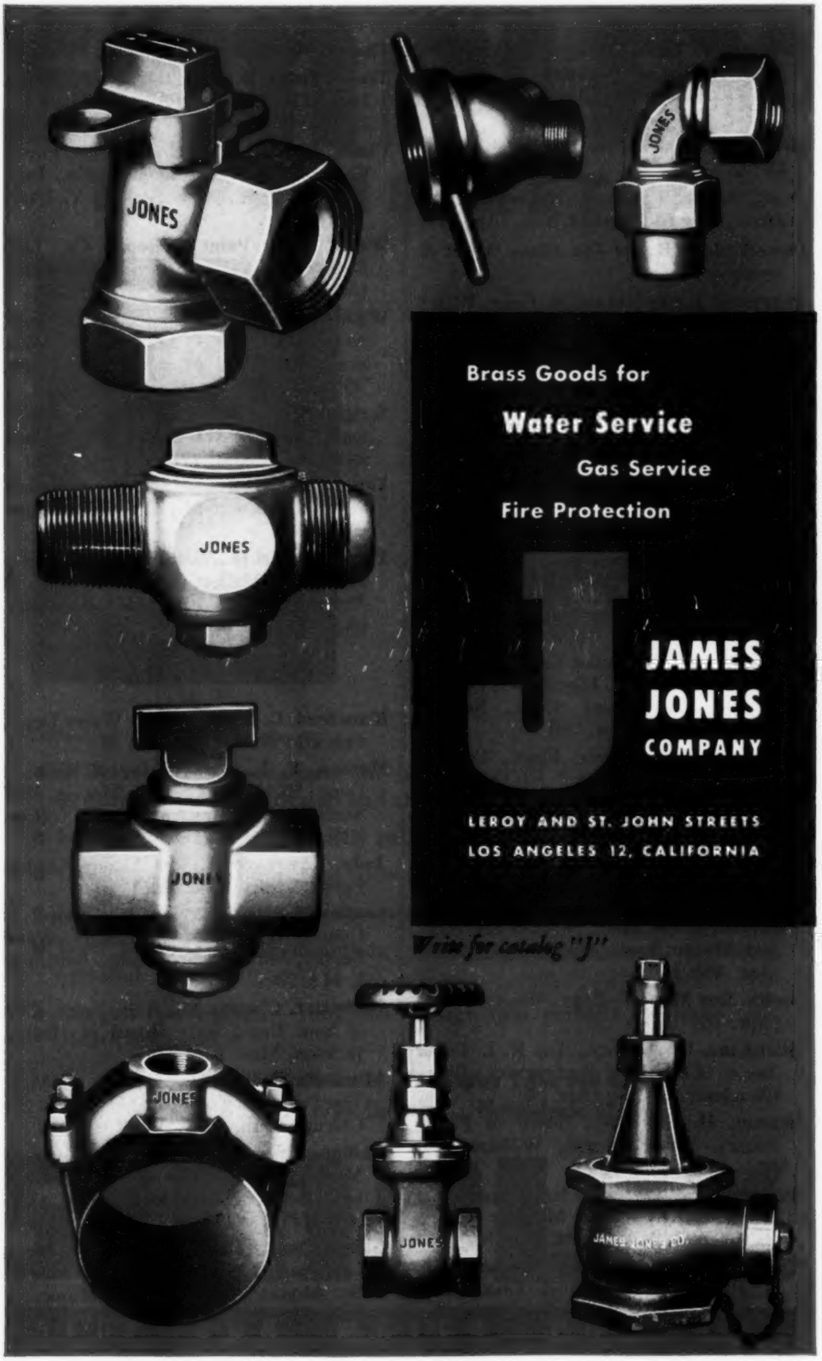
Moore, John B., Jr., Sales Engr., Owens-Corning Fiberglas Corp., 68 Post St., San Francisco 4, Calif. (Apr. '49) *M*

Morrow, M. E., *see* Century Geophysical Corp.

Newburgh Water Dept., Howard R. Patton, Supt., 79–81 Dubois St., Newburgh, N.Y. (Munic. Sv. Sub. Apr. '49)

Olsen, David L., Supt., Palatine Hill Water Dist., Palatine Hill Water Co., 12031 S.W. Breyman, Portland, Ore. (Apr. '49) *M*

(*Continued on page 34*)



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(*Continued from page 32*)

Paré, G. A. Y., Gen. Mgr. & Vice-Pres., Parco Drilling & Exploration Co., Ltd., 111 Mountain Hill, Quebec, Que. (Apr. '49)

Patton, Howard R., *see* Newburgh Water Dept.

Peart, Robert F., Supt., Water & Light Dept., City Hall, Beloit, Kan. (Apr. '49)

Powers, John B., *see* Texarkana Water & Sewer Systems

Pritchard, James Nelson, Jr. Engr., Water Works Dept., 48 Rideau St., Ottawa, Ont. (Apr. '49)

Pure Carbonic, Inc., R. S. Frichett, Asst. Gen. Sales Mgr., 60 E. 42nd St., New York 17, N.Y. (Assoc. M. Apr. '49)

Randall, Burl E., Supt., Water Dist., Alderwood Manor, Wash. (Apr. '49) *MPR*

Risquez C., Alfonso A., Student, Public Health Eng. & San. Eng., Univ. of Minnesota, Unit P-95 University Village, Como & 29th Aves., S.E., Minneapolis 14, Minn. (Jr. M. Apr. '49)

Rogers, John C., Water Supt., Montrose, Mich. (Apr. '49)

Saskatchewan Provincial Govt., Dept. of Public Works, E. E. Eisenhauer, Deputy Minister, Parliament Bldgs., Regina, Sask. (Corp. M. Apr. '49)

Scales, William, Munic. Engr., Dawson Creek, B.C. (Apr. '49)

Schneider, Ernst E., Supt., Light & Water Com., Cedarburg, Wis. (Apr. '49) *MP*

Schuerholz, Leroy V., Prin. Assoc. Engr., Bureau of Water Supply, 503 Municipal Bldg., Baltimore 2, Md. (Apr. '49)

Sherman, David Alton, Serviceman, Newport Munic. Water Co., Newport, Ark. (Apr. '49) *M*

Smith, Roy M., City Engr., Hesston, Kan. (Apr. '49)

Stadthaus, H. A., Secy., The R. L. Fuller Assoc. Co., 501 Auditorium Bldg., Cleveland 14, Ohio (Apr. '49)

Stamm, H. F., Supt., Board of Public Affairs, Water Works, Williamsburg, Ohio (Apr. '49)

Taylor, Boyd C., Sr. Clerk, Bureau of Water Supply, 1102 McAleer Court, Baltimore 2, Md. (Jr. M. Apr. '49)

Texarkana Water & Sewer Systems, John B. Powers, Mgr., 4th & Texas, Texarkana, Ark. (Corp. M. Apr. '49)

Thomas, William, *see* Maywood, Village of

Travis, Frank D., Dist. Repr., Inertol Co., Inc., 1721 Minnesota Ave., Kansas City 2, Kan. (Apr. '49)

Ulmer, Richard C., Tech. Director, Power Chems. Div., E. F. Drew & Co., Inc., 15 E. 26th St., New York, N.Y. (Apr. '49) *P*

Water Tower Paint & Repair Co., Earl Bagenstos, Pres. & Mgr., Clear Lake, Iowa (Assoc. M. Apr. '49)

Watkins Glen Water Dept., W. F. Frost, Asst. Supt., 303 N. Franklin St., Watkins Glen, N.Y. (Munic. Sv. Sub. Apr. '49)

Wright, K. W., Sales Engr., Jos. W. Eshelman Co., Inc., 314 Wilder Bldg., Charlotte, N.C. (Apr. '49)

Young, B. C., Munic. Soft Water Plant, 501 E. Carpenter St., Hutchinson, Kan. (Apr. '49)

Young, Robert H., Water Works & Sewerage Engr., Mallett & Assoc., Engrs. & Architects, Box 1065, Jackson, Miss. (Apr. '49) *MPR*

REINSTATEMENTS

Blanchard, C. A., Supt., City Water Dept., Ephrata, Wash. (Jan. '41) *M*

Harden, E. L., Mgr., Valve & Hydrant Dept., Rich Mfg. Co. of California, 3851 Santa Fe Ave., Los Angeles, Calif. (Oct. '42) *M*

Judy, Lawrence B., *see* Skagit County Public Utility Dist. No. 1

Lamley, George E., Sr. Asst. Supt. of Constr. & Maint., Bureau of Water Supply, 506 Municipal Bldg., Baltimore 2, Md. (Oct. '42) *M*

Ledbetter, Charles M., Asst. Engr., Div. of San. Eng., State Board of Health, Jackson, Miss. (Oct. '39)

Mitchell, William H., Dist. Sales Mgr., The Permutit Co., 407 S. Dearborn St., Chicago 5, Ill. (Jan. '35) *P*

Philips, Everett A., Constr. Engr., La Mesa, Lemon Grove & Spring Valley Irrigation Dist., La Mesa, Calif. (Apr. '47) *MPR*

Skagit County Public Utility Dist. No. 1, Lawrence B. Judy, Mgr., 313 Kincaid St., Mount Vernon, Wash. (Munic. Sv. Sub. Apr. '44)

(*Continued on page 36*)

(*Continued from page 34*)

Thomas, W. M., Feemster & Striger, 517 S. Spring St., Tupelo, Miss. (Jan. '47)

Wedeman, John D., Chief of Water & Sewage, Engr. Sec., Headquarters 4th Army, Fort Sam Houston, Tex. (Apr. '46)

LOSSES

Death

Frame, Paul D., Owner & Mgr., Ulrich Chemical Co., 31 E. Georgia St., Indianapolis 4, Ind. (Dec. '37) *P*

Resignation

Palisades Del Rey Water Co., Management Div., C. C. Hagar, Gen. Mgr., 411 W. 5th St., Los Angeles 13, Calif. (Corp. M. Oct. '43) *M*

CHANGES IN ADDRESS

Changes received between May 5 and June 5, 1949

Adams, E. B., Supt., Water Works, Albany, Ga. (Jan. '49)

Beall, R. R., Delphia, Ky. (Affil. Oct. '42)

Bennett, Richard, Hydr. Engr., 75 W. Culver St., Phoenix, Ariz. (Apr. '29) *M*

Berk, Ralph G., Great Lakes Div., Corps of Engrs., Chicago, Ill. (July '41) *PR*

Bisler, Walter E., Distributor, Flexible Underground Pipe Cleaning Co., 402 Poplar St., Warren, Pa. (Oct. '48)

Brashears, M. L., Jr., Dist. Geologist, U.S. Geological Survey, Water Resources Div., 222 Old Country Rd., Mineola, N.Y. (Apr. '44) *M*

Brown, Herbert B., Dist. Mgr., Neptune Meter Co., 4048 W. Taylor St., Chicago 24, Ill. (Jan. '46)

Clark, M. S., Dist. Sales Mgr., Mathieson Chemical Corp., Rialto Bldg., St. Louis 2, Mo. (Apr. '37)

Clark, Owen E., Constr. Engr., Div. of Water, 565 Erie St., Toledo 2, Ohio (Oct. '38) *P*

Columbus Light & Water Dept., James L. Mattox, Supt., Columbus, Miss. (Corp. M. July '48)

Cook, Will W., Sales Engr., Proportioneers, Inc., 323 Colman Bldg., Seattle 4, Wash. (Apr. '38) *PR*

Daniels, Roy D., Chemist, Water Works, 508 Roselynne Ave., Parkersburg, W.Va. (Jan. '47) *P*

Decker, A. Clinton, 1125 S. 22nd St., Birmingham 5, Ala. (June '14) *Diven Medal '48. Director '47–'50. P*

De Haven, Edward, Branch Mgr., Culligan Zeolite Co., 5540—13th Ave., S., Minneapolis, Minn. (Apr. '47)

Dodson, Joseph W., Dist. Sales Mgr., Culligan Zeolite Co., 2651 Clague Rd., Westlake, Ohio (Apr. '47)

Earnhardt, Kenneth B., Asst. Mgr., Alexandria Water Co., Alexandria, Va. (Apr. '47) *MP*

Gardner, Dion L., Cons. Geologist, 1815 W. Chapman St., Orange, Calif. (Oct. '45) *R*

Gidley, Harry K., Div. of San. Eng., State Dept. of Health, Charleston 5, W.Va. (Jan. '39) *Fuller Award '45. Director '46–'49. P*

Gonzalez, Carlos E., Box 405, Quito, Ecuador (Jr. M. Jan. '49)

Gordon, Fred F., Cons. Engr., 72 Augustine St., Rochester 13, N.Y. (July '35) *P*

Havill, Harold T., 826 Sunset Rd., West Palm Beach, Fla. (June '02) *M*

Henderson, Paul C., U.S. Public Health Service, 239 Federal Office Bldg., San Francisco, Calif. (Apr. '46)

Hurd, Charles H., Cons. Engr., 725 E. 57th St., Indianapolis 20, Ind. (Jan. '45) *P*

Jones, Malcolm S., Jr., Lt., Dist. Public Works Office, Headquarters 15th Naval Dist., F.P.O. 121, New York, N.Y. (Apr. '47)

Jones, William Clark, Div. Engr., Bureau of Eng., Water Dept., 565 Erie St., Toledo 2, Ohio (Jan. '47) *P*

Kendrick, Edward J., Box 322, Sidney, N.Y. (Apr. '46)

Kozma, Albert B., Gannett, Fleming, Corddry & Carpenter, Inc., 600 N. 2nd St., Harrisburg, Pa. (Affil. Jan. '44) *P*

Liffen, John J., Assoc. Engr., Associated London Properties, Ltd., 58 Hendham Rd., Wadsworth Common, London S.W. 17, England (July '38) *M*

Mau, Gordon E., San. Engr., Univ. of Kansas, 2 Marvin Hall, Lawrence, Kan. (July '43) *P*

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Mehta, K. D., Asst. Engr., I Div., P.H. E.D., Meerut (U.P.), India (Apr. '48)

Merryman, Harold W., Asst. San Engr., State Board of Health, 1022 S.W. 11th Ave., Portland, Ore. (Apr. '36) *MP*

Miller, Frank H., Chief Engr., Hampton Roads San. Com., Lamberts Point, Norfolk, Va. (Apr. '42) *PR*

Mills, H. L., Box 804, Helena, Mont. (Jan. '48)

Morlan, Loren W., Chief Clerk, Water Dept., 1374 Lakewood Ave., Lakewood 7, Ohio (Jan. '49)

Perkins, James H., Langhorne, Pa. (Jan. '46) *P*

Pickett, Arthur, Indus. Waste Engr., Los Angeles County, 622 Los Angeles County Eng. Bldg., 108 W. 2nd St., Los Angeles 12, Calif. (Oct. '47) *PR*

Priess, O. L., Sales Dept., Crane O'Fallon Co., 1601 Ulster St., Denver 7, Colo. (July '37)

Redmond, John, Jr., Capt., Brooke AMC, Fort Sam Houston, Tex. (Oct. '46)

Rimbach, T. N., Lane Machinery Co., 707 Market St., St. Louis 1, Mo. (Apr. '40) *P*

Roberts, F. C., Jr., Sr. San. Engr., U.S. Public Health Service, c/o Servico de Saude do Interior, Rua Euclides da Cunha No. 1, Salvador, Bahia, Brazil (July '35)

Sanborn, James F., 607 Commercial St., Provincetown, Mass. (Aug. '21)

Siebert, Harry J., Sales Engr., Neptune Meter Co., 2441 Vail Ave., Charlotte, N.C. (July '45)

Signor, C. V., City Mgr., City Hall, Pendleton, Ore. (Apr. '36) *MP*

Simmonds, M. A., c/o N. Pollock, 502 Main Coast Rd., Scarborough, Queensland, Australia (July '37)

Soteldo Ramos, J. M., Director, Acueductos de Caracas, Sur 15, No. 123, Caracas, Venezuela (Jan. '49)

Stewart, Morgan E., 120 Arbor Drive, Piedmont 10, Calif. (Jan. '44) *P*

Tait, Robert E., San. Engr., Public Health Eng. Div., Dept. of National Health & Welfare, General Motors Bldg., Moncton, N.B. (Apr. '49)

Tanner, William S., O. R. Dahms Constr. Co., Route 7, Box 1143, Sacramento, Calif. (Jan. '45) *MPR*

Thomas, H. W., Pacific Northwest Mgr., Badger Meter Mfg. Co., 543—1st Ave., S., Seattle 4, Wash. (Oct. '41)

Trygg, Charles E., State Health Dept., State Capitol Bldg., Phoenix, Ariz. (Oct. '42) *P*

Vass, E. M., City Engr., Fredericksburg, Pa. (Jan. '47)

Walter, Herbert A., Sales Engr., Southern Pipe & Casing Co., 2385 Lorain Rd., San Marino, Calif. (Apr. '48)

Webber, Weston L., 110 Ladera Drive, Santa Cruz, Calif. (Jan. '47) *MR*

Weiner, Daniel J., Water Pollution Control, Missouri River Basin Office, 417 E. 13th St., Kansas City 6, Mo. (July '46)

Williams, Fred, 270 Huxley Ave., S., Hamilton, Ont. (Apr. '46) *MP*

Wilson, James F., Sr. Utilities Engr., California Public Utilities Com., 1000 Mirror Bldg., Los Angeles 12, Calif. (Jan. '45) *MPR*

Wolf, Harold W., 1308 Columbia Ave., N.E., Grand Rapids 5, Mich. (Jr. M. Apr. '48)

Condensation

Key: In the reference to the publication in which the abstracted article appears, **39**:473 (May '47) indicates volume 39, page 473, issue dated May 1947. If the publication is paged by the issue, **39**:5:1 (May '47) indicates volume 39, number 5, page 1, issue dated May 1947. Abbreviations following an abstract indicate that it was taken, by permission, from one of the following periodicals: *B.H.—Bulletin of Hygiene (Great Britain); C. A.—Chemical Abstracts; I. M.—Institute of Metals (Great Britain); P.H.E.A.—Public Health Engineering Abstracts; W.P.R.—Water Pollution Research (Great Britain).*

FILTRATION

General Considerations of Water Filtration. R. Buydens. Tech. Sanit. (Fr.), **43**:43 (May–June '48). Discussion of development and evolution of slow and rapid sand filters, with specific reference to sand sizes, factors affecting water passage through filters, filter rates, depth of sand beds, water and air diffusers, filter bottoms and various types of filter media. After 75 years of study and progress possibility of better and more economic filters is not excluded. —*W. Rudolfs.*

Slow Filters—Construction of Filter Basins. H. Julien-Laferière. Tech. Sanit. (Fr.), **43**:48 (May–June '48). Slow filtration characterized by screens and prefiltration before final filtration and absence of coagulants. Sterilization, indispensable in rapid filtration, is complementary and used for security. Initial cost of construction is higher but security outweighs expense. Bacteriological examination requires at least 48 hr. and water has been distributed in the meantime.—*W. Rudolfs.*

Construction and Operation of Rapid Sand Filters. R. Leviel. Tech. Sanit. (Fr.), **43**:67 (May–June '48). General discussion of filter rates, sand sizes, quality and quantity of sand required for optimum filtration. Conclusion reached that rapid sand filtration process is simple; only coagulation and sterilization need careful control.—*W. Rudolfs.*

The Operation of Rapid Sand Filters. Norman J. Howard. Eng. Cont. Rec. (Can.) **61**:3:80 (Mar. '48). Three most important factors: conditioning of raw water, correct size and depth of sand, and adequate washing. Chemicals available for coagulation outlined. Turbidity of filter influent should be 5 ppm. or less. Rates of filtration as high as 3 gpm./sq.ft. employed in modern plants. Good removals of bacteria and turbidity effected with sand with E.S. 0.65 mm. Anthrafilt has possibilities. Surface washing has frequently reduced operating difficulties.—*R. E. Thompson.*

Diatomite Filtration as Developed by the Canadian Army. G. F. Bradbury. Wtr. & Sew. **87**:1:20 (Jan. '49). Diatomite filtration, which consists of filtering water through removable layer of fine powder supported on undeformable metal structure, patented in England in '28 and approved for use by British army. Degree of purif. possible ranges from clarification to complete removal of bacteria, depending upon porosity of filtering layer and rate of filtration. For service use, filtration relied upon to produce clarity and considerable reduction in bacteria, disinfection being effected by chlorination. Supporting structure for filtering layer consists of series of monel metal rings, one side flat and other scalloped, assembled in column or pack on rod with 3 longitudinal flutes into which filtered water flows and passes upward and away to storage. Filtering area can

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be varied by increasing length or no. of columns in filter unit. Army filter comprises 6 columns, each made up of about 265 rings, normal rated capac. being 100 gal./sq.ft. of surface. Cleaning effected by reverse flushing with filtered water. Frequent back-flushing necessary when water contains grease or fine clay. Several types of commercial diatomaceous earth used successfully—bulk density of one is about 0.2 g./ml. and, as sp. gr. of SiO_2 is 2.5, voids are of order of 92%. Ceramic elements, suggested by A. V. Delaporte, exptd. with in '42 as substitute for scarce metal rings. These gave satisfactory filtrate and no blocking not removable by back-flushing occurred. Even fungoid growths induced by immersing in water contg. sewage fungi readily removed. Flow rate slightly greater than with metallic elements under same conditions but care in assembling necessary because of brittleness. Two filters, 200-gal. storage tank and pumps mounted on short-wheel-base army truck; 200 gal. filtered in about 20–25 min. Working pressure controlled by relief valve set at 60 psi. Backflushing when 40 psi. reached. Often water pumped directly from source without pretreatment.—*R. E. Thompson.*

Elimination of Animal Plankton Through a New System of Rapid Sand Filtration. J. P. Buffle. Tech. Sanit. (Fr.) **43**:107 (Sept.–Oct. '48). Lab. studies to remove animal plankton by coagulation and settling produced poor results because organisms settled at very low rate; use of copper sulfate produced incomplete removal because number of organisms resistant; light elimd. organisms incompletely. In sand filtration various factors important: temp., filtration rate, size and form of grains, chem. compn. of sand, variation in resistance to water passage, underdrains, elec. charges of particles in water, elec. charge on

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sand. Studies made through various membranes: [1] silk with openings of 0.07 mm., [2] bronze with openings of 0.05 mm., [3] porcelain plate and [4] porous ebonite. Natural plankton from Lake Geneva used (concd. by centrifuging) in sizes 0.20–0.024 mm. Plankton retained varied from 55 to 83%, depending upon type of organisms. Exptl. sand filters with various types of inlets, cleaning mechanisms and underdrains led to constr. of rapid sand filter with porous bottom and backwashing with air and water. Results show avg. removal of 96% of plankton up to 100% with more easily retained organisms. No traces of clogging or cracking of porous plates after 3 yrs.; wash water used avgd. 0.5%, max. 1.5%; sand bed remained intact; filtration rates 4.3 to 10.8 mph.—*W. Rudolfs.*

How to Utilize Natural Sands for Rapid Filtration. P. FRISON. L'Eau (Fr.) **36**:725 (Jan.–Feb. '49). Natural river, dune and sea sands plentiful in France but not used for water filtration. Utilization of sand controlled by its cleanliness, chem. compn., effective size and uniformity coefficient. For prelim. examn. pour some sand in water and observe cleanliness; for chem. compn. put sand in 20% HCl for 24 hours and dry; loss should be less than 5%. Examples and results given, also methods of calcn. Comparison of the Hazen and Baylis methods for number of natural sands shows that effective sizes calcd. by Baylis method always low, but avg. differences only about 5–6%. Author believes both methods of determining effective size aad uniformity coefficient equally usable, provided chemical characteristics of sand known.—*W. Rudolfs*

Slow Filtration of River Water. G. A. SCHROEYERS. Tech. Sanit. (Fr.) **43**:101 (Sept.–Oct. '48). Natural slow filtration considered most important. Water may penetrate through autotrophic or allotrophic beds. Water which has penetrated through autotrophic bed does not contain much material in soln. as compared with that passed through allotrophic bed. Artificial slow sand filters normally 1.20 to 1.60 m. deep, filtering at rate of 10 cm./hr. With presettling rate can be increased to 15–25 cm./hr. Biol. film important in purif. but may result in odors. Sand used in Belgium usually has diam. of 0.25 mm. and uniformity coefficient of 1.5, allowing surface area of 15,000 sq.m. per cu.m. of sand. Filter runs vary from 60 to 120 hr. Effluent, treated with 10 ppm. hypochlorite, contains no coliform organisms and annual avg. of 22 bacteria (20°C.) per ml. In open slow filters biol. growth, particularly green algae, play important role. Closed filters have less biol. life and may filter at higher rate, but qual. of effluent will be poorer. In U.S. rapid mech.-chem. filtration methods, absence of biol. growth requires chlorination for safety; in Belgium they prefer mech.-biol. filtration. Abandonment of method used would result in material reduction in qual. of water now distributed.—*W. Rudolfs.*

ANNUAL REPORTS

Pasadena (Calif.) Water Dept. Annual Report (Year Ending June 30, 1948.) Organized in '12 by purchase of 3 water companies, 33 other systems acquired. Water consumption 19.8 mgd. or 152 gal. per capita. Distr. system 393 mi. of 2″–36″ mains, 1981 hydrants and 33,720 services, 100% metered. 32% of water obtained from wells, 8% by gravity and 60% from Colorado R. by purchase from Metropolitan Water Dist. Gross revenue $1,477,587, gain of $185,660 over previous year. Expenses $1,337,555, increase of $101,555. Fixed assets, less depreciation, $5,224,046. Total liabilities $165,765. Payment to gen-

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eral fund of city $73,607. Water rates increased 20%.—*O. R. Elting.*

Santa Cruz (Calif.) Annual Report (June 1948). First cost of plant $2,813,175. Bonds $200,000. Income $212,529. Operation and maint. $103,003. Water consumption 5.07 mgd. 74% sold.—*P. R. Elting.*

Hartford (Conn.) Water Bureau, Metropolitan District. Annual Report (1947). Organized '29. Dist. includes Hartford and 7 adjoining municipalities. Estd. pop. served 312,000; yearly avg. 31.54 mgd. Gravity supply. Distr. of revenue dollar, supply 6.4¢, purif. 3.9¢, distr. 10.6¢, acctg. 3.5¢, administration 15.8¢, taxes 1.6¢, depreciation 15.1¢, fixed charges 39.9¢, surplus 3.2¢. Distr. system of 640 mi. serves 41,032 services (40,006 metered) and 4162 hydrants. Gross revenue $1,815,752. Operating expense $814,223. Fixed capital $32,672,153; bonded debt $9,493,000; net worth $14,723,239. Consumption in excess of 30 mgd. occurred on 248 days as against 151 days in '46.—*O. R. Elting.*

Des Moines (Iowa) Water Works Annual Report (1948). Operates under a 5-man board of trustees. Pop. 187,314, consumption 20.42 mgd. or 109.0 gal. per capita. Water under pressure of 38–118 psi. delivered through 452 mi. of 4″–36″ mains to 3860 hydrants and to 43,799 services, 99.6% metered. Meters billed 80.6% of water pumped. Gross income $1,342,856; operation and maint. $608,382, depreciation $131,358, interest and sinking fund $277,696, invested capital $212,771. Plant, less depreciation, $8,452,423; Total assets $9,562,232. Bonded debt $2,811,000. City's equity $6,186,340. Pumping max. 42.9 mgd.; min. 8.7 mgd.; avg. 20.42 mgd. Coal 16.0% ash, 8791 Btu. as fired. Rainfall 28.74″–3.34″ below normal; air temp.

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avg. 51°F., max. 90°., min. −2°; water temp. avg. 56°F., max. 72°, min. 42°.—*O. R. Elting.*

Dubuque (Iowa) Water Dept. Annual Report (Year Endign Mar. 1948). City manager with mayor and council. 8 artesian wells 1300–1781′ deep, 6″–16″ diam. and mine tunnel. Pump capac. 35 mgd., storage 11.7 mil.gal., 123 mi. of mains, 953 hydrants, 10,383 services 100% metered. Pop. '40, 43,892, consumption 3.72 mgd. Depreciated value of plant $1,788,494; investment $160,000. No bonded debt. Operating revenue $217,205; operation and maint. $111,815; main extensions and other betterments $128,827. Water salable 74%. Recommended improvements: 8-mgd. softening plant; 0.5 mil.gal. storage reservoir, 24″ feeder main; feeder mains, warehouse and repair shop, two pumping units. No tax levy or hydrant rental. 25% of salaries of city manager, auditor and treasurer paid from water funds.—*O. R. Elting.*

New Orleans (La.) Sewerage and Water Board. Annual Report (1947). Pension system established in '42. Board contributes 3% of payroll. New constr. costs for sewerage, water works and drainage met by taxation; operation and maint. met by water rents; city budget pays for operation of drainage system, but latter does not meet requirement and some income contributed by water works and sewerage funds. Lack of finances and unstable condition of pipe market hampered carrying out of much needed improvements. Improvements total $33,000,000 urgent. Total water, sewerage and drainage assets $83,054,108. Outstanding bonds

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$12,728,000; water works and sewerage operation income $2,358,506; expense $2,012,336. 97,953 services, 95,901 metered, 899 mi. 2–48" mains, 8637 hydrants.—*O. R. Elting.*

Elmira (N.Y.) Water Board Report (1947). Municipally owned since '15. Elected board, 5 men, overlapping terms. Pop. served 65,000; 7,021 mgd; 165 mi. of mains 4" and larger; 854 hydrants; 15,112 serivces, 100% metered. Plant first cost $3,100,082; depreciation $891,127; cast, investments and special fund reserves $223,532; debt free. Income $320,587; operating costs, including taxes and depreciation, $351,150. Supply from Hoffman Creek (34%), gravity; Chemung R. (66%), pumped. Purif. plant of 24 rapid sand filters. Reservoir capac. on distr. system total 6.5 mil.gal. Capital expansions have been made from revenue. Increased cost of operation and maint. and constr. will require addl. funds for needed expansion.—*O. R. Elting.*

Cleveland (Ohio) Division of Water and Heat. Annual Report (1947). Receipts $7,865,923, expenditures $7,799,409. Cash balance Dec. 31, $3,640,823. Fixed assets $65,671,147. Surplus $28,751,957. Reserve for depreciation $31,617,436. Bonded debt $18,203,000, offset by investments and sinking fund of $11,492,883. 225 mgd. supplied to 2819 mi. of main serving 36,020 hydrants and 194,092 services 99.5% metered. Pop. served 1,312,630, located in city of Cleveland and 47 suburban municipalities, 4 of which have master meters. Per capita consumption 171 gpd. 83.2% of water accounted for by meters. 3 main and 9 secondary stations lift Lake Erie water to 4 service pressure dists. Pump capac. all services 1083 mgd. 2 purif. plants of 315 mgd. capac. Cost of delivering water to distr. plus operation and maint. $47.14 per mil.-gal.—*O. R. Elting.*

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Erie (Pa.) Bureau of Water Annual Report (Dec. 31, 1947). Pop. served 138,000. 29,454 active services, 5% metered. Consumption 38.46 mgd., 278 gal. per capita, 310 mi. mains, 1695 hydrants. Income $891,339, expenditure exclusive of depreciation $953,320. This includes $97,142 capital expense and $180,950 new plant. Fixed assets (depreciated) $9,935,824, cash $548,347, bonds outstanding $806,000. Lake Erie water. Chestnut St. plant 17,641′ of 60″ intake; 24-mil.gal. settling basin; low-lift pumps 3–20 mgd.; 32-mgd. filter plant; high-lift pump 60-mgd. total capac. West plant 8,745′ of 72″ intake; 34-mgd. low-lift station; 24-mgd. filtration plant; 32-mgd. high-lift pump capac. Two service dists. with 33-mil.gal. and 10-mil.gal. storage. Two standpipes of 440,000 and 400,000 gal., with booster stations servicing outlying dists. Contracts awarded for 3 new pumps, total capac. 52 mgd., for various services. New 14-mgd. low-lift pump installed and ready for operation.—*O. R. Elting.*

Greenville (S.C.) City Water Works. Auditor's Report (Year Ending July 31, 1948). Gross income $567,116. Net profit from operation $349,300, compared with $291,947 for '47. Of this sum $170,000 applied to capital charges; $134,448 to addns. to plant. Plant and equip. $5,433,637. Total assets $6,100,461. Surplus (excess of assets over liabilities) $3,174,338.—*O. R. Elting.*

Uvalde (Texas) Annual Report (June 1948). Munic. water plant purchased '28, cost $125,000, present valuation $380,463. Outstanding bonds $149,000. Water from four wells

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260–400′ deep in limestone. Water rises to within 40′ of surface, 28 mi. of main, 250,000-gal. storage. Income $74,085; expense $54,782, includes $12,000 for garbage collection.—*O. R. Elting.*

Green Bay (Wis.) Water Dept. Annual Report (1948). Five-man board of commissioners. Gross income $319,957; operating expense $146,505; taxes $45,714; depreciation $32,557; interest $34,970; surplus $60,210. First cost of plant $2,509,000. Bonds outstanding $557,000. Mains 144 mi., 12,112 metered services, 828 hydrants. Avg. consumption 5.08 mgd., 104.6 gpd. per capita, 86.1% water sold. Pumpage greatest in history. Water obtained from 8 wells. Addnl. supply needed.—*O. R. Elting.*

Brockville (Ont.) Annual Report (1947). W.W. Inf. Exch.—Canadian Sec. A.W.W.A., **7**:E:2:3 (Apr. '48.) Supply from St. Lawrence R. chlorinated. Pop. served 14,000. Avg. pumpage 3.39 mgd., increase of 0.23. Services 3322 (only 57 metered), hydrants 181. Water supplied free to all consumers for 6 mo. Net revenue $37,772.01, profit $3,083.35. Details of rates included.—*R. E. Thompson.*

Chatham (Ont.) Annual Report (1947) W.W. Inf. Exch.—Canadian Sec. A.W.W.A., **7**:E:7:13 (Dec. '48). Supply from Thames R., filtered and chlorinated. Consumption by 23,000 pop. avgd. 3.73 mgd. (U.S.)—162 gpd. per capita. Chemicals used: alum, ammonium sulfate and chlorine, latter avg. 17.4 lb./mil.gal. Water cost per 1000 Imp. gal. $6.50. Receipts $166,679.40; disbursements $189,457.30. Assets $1,074,793.41. Mains 51.8 mi.; services 5013; hydrants 294 (5.6 per mi. of main.).—*R. E. Thompson.*

Guelph (Ont.) Annual Report (1947). W.W. Inf. Exch.—Canadian Sec.

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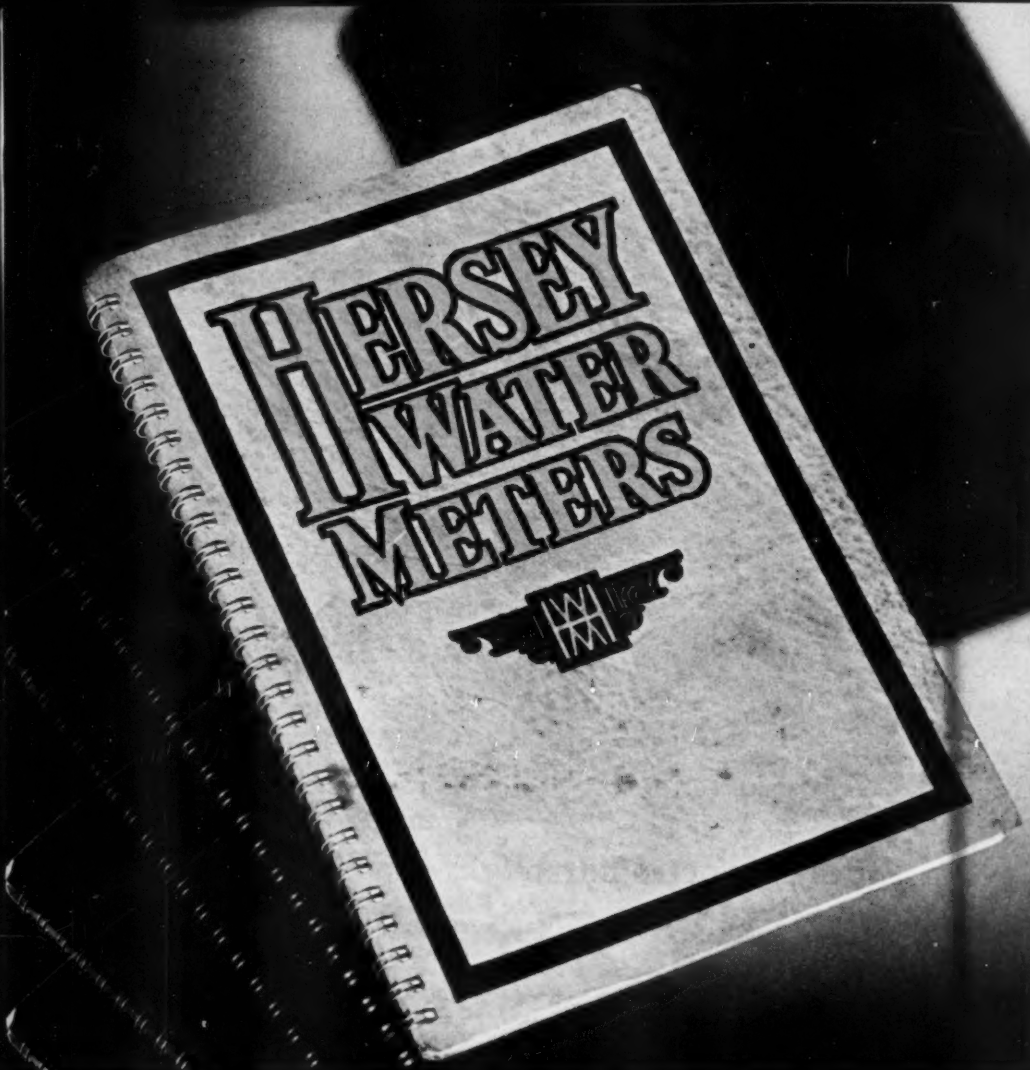
HERSEY WATER METERS

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A.W.W.A., **7**:E:8:14 (Dec. '48). Supply from springs and wells, chlorinated. Pop. 27,077. Consumption avgd. 5.12 mgd., 189 gpd. per capita. Total cost of pumping $12.06/mil.gal. Services 6525; hydrants 274; meters 230; mains 56.8 mi. (12′ per capita).—*R. E. Thompson.*

Oshawa (Ont.) Annual Report (1947). W.W. Inf. Exch.—Canadian Sec. A.W.W.A., **7**:E:6:12 (Dec. '48). Supply from L. Ontario, filtered and chlorinated. Consumption 1117.72 gal. by 33,924 pop. (6000 outside city limits)—5768 of 6999 customers metered. Suburban monthly rates 20¢/100 cu.ft. up to 1000 cu.ft.; 14.4¢ plus service charge for each addnl. 100 cu.ft.; 10% discount for prompt payment. Income $201,727.22, expenditures $198,364.84, surplus $3,362.38. Investment in system $1,359,761.06; debenture debt $77,485.63.—*R. E. Thompson.*

OTHER ARTICLES NOTED

Recent articles of interest, appearing in American periodicals not abstracted, are listed below.

International Joint Commission Study of the Detroit River. M. LeBosquet Jr. Sew. Wks. J., **21**:525 (May '49).

Relation of Stream Characteristics to Disposal of Chemical Manufacturing Effluents. V. L. King et al. Sew. Wks. J., **21**:534 (May '49).

Municipal Public Relations. Anon. Pub. Management, **31**:3:77 (Mar. '49).

Recent Labor Legislation and Its Effects on Public Utility Operations. John H. Murdoch, Jr. J.N.E.W.W.A., **63**:1:14 (Mar. '49).

A Critical Review of the Literature of 1948 on Sewage and Waste Treatment and Stream Pollution. FSWA Committee on Research. Sew. Wks. J., **21**:2:228 (Mar. '49).

An Engineering Concept of Flow in Pipes. Charles W. Harris. Proc. A.S.C.E., **75**:555 (May '49).

Water Hammer and How to Control It. Philip S. Davy. Pub. Wks., **80**:5:30 (May '49).

High Cost of Quantity Surveys Works Against Their Adoption. Leslie H. Allen. Eng. News-Rec., **142**:17:51 (Apr. 28, '49).

Supersonic Methods Short-Cut Reservoir Silt Measurements. Charles W. Thomas. Civ. Eng., **19**:5:43 (May '49).

Reservoir Sedimentation in Limestone Sinkhole Terrain. Gunnar M. Brune. Agr. Eng., **30**:2:73 (Feb. '49).

Multipurpose Reservoirs Aid Downstream Water Supply. F. W. Kittrell & John J. Quinn. Eng. News-Rec., **142**:21:42 (May 26, '49).

Aerial Spraying Controls Reservoir Growths. Anon. Pub. Wks., **80**:5:23 (May '49).

Water and Sewage Chemistry and Chemicals. Anon. Pub. Wks., **80**:5:50 (May '49).

Simplified Amperometric Titration Apparatus for Determining Residual Chlorine in Water. W. A. Mahan. Wtr. & Sew. Wks., **96**:5:171 (May '49).

Effect of Various Aqueous Solutions Upon the Reactions at Pure Iron Anodes and Cathodes—Part II. W. W. Kittelberger & A. C. Elm. Corr., **5**:5:155 (May '49).

Porous-Plate Filter Underdrains. Frank C. Roe. Wtr. & Sew. Wks., **96**:6:225 (June '49).

A Novel Foam System. C. L. Jones. N.F.P.A. Quart., **42**:248 (Apr. '49).

Present Status of Organic Synthetic Detergents. A. B. Hersberger & C. P. Neidig. Chem. & Eng. News, **27**:1646 (June 6, '49).

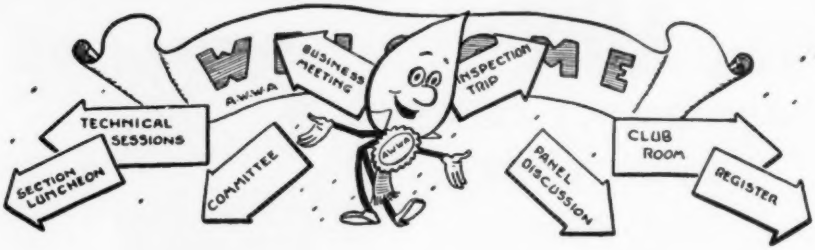
Service Lines

Amine treatment for corrosion prevention through the combined effect of increasing the pH of the water and surface protection of the metal itself is the subject of a new booklet issued by the Bird-Archer Co., 400 Madison Ave., New York. Entitled "Corrosion Protection of Steam and Condensate Return Systems," the 4-page folder is available upon request.

Magnesium anodes for cathodic protection are described in several information sheets issued by Dowell, Inc., which has taken over their marketing from the parent company, the Dow Chemical Co. Complete details about the anodes, including dimensions, weight, electrical rating and price information are provided. The illustrated sheets are obtainable from Dowell, Inc., Kennedy Bldg., Tulsa 3, Okla.

An air-powered pipe saw is described in literature available from the E. H. Wachs Co., 1525 N. Dayton St., Chicago 22. The device cuts cast-iron or steel pipe from 12 to 48 in. in diameter at a rate of 2 in. per minute.

"Preload Tanks," a handsomely prepared and illustrated 24-page booklet, discusses in detail the origin, uses, design and construction of wire-wound concrete tanks. Included are specifications for materials, a capacity chart for Preload tanks of various diameters and heights, and construction photographs. The Preload Corp., 211 E. 37th St., New York 16, will supply copies upon request.



Section Meeting Reports

California Section: Two hundred and forty-six members and guests gathered in Bakersfield on April 29, 1949 for the second spring regional meeting of the California Section of the American Water Works Association. All functions of the meeting were held in the Bakersfield Inn, headquarters hotel for the conference.

Chairman Grayson opened the technical sessions with a few words of welcome and Frank Miramontes, Supervisor of Pump Testing, Pacific Gas and Electric Company, San Francisco, presented the first paper on "Deep Well Pump Testing to Maintain Minimum Pumping Costs." The second paper on "Present Status of Ground Water Levels in Southern San Joaquin Valley" was presented by Irvin M. Ingerson, senior hydraulic engineer of the Division of Water Resources, State Department of Public Works, Sacramento. The "Panel and Open Discussion on Distribution System Complaints" led by W. W. Aultman, water purification engineer of the Metropolitan Water District of Southern California, closed the morning program. The subject was divided into three parts: "Common Causes of Distribution System Complaints," discussed by L. L. Flor, sanitary engineer of the La Mesa, Lemon Grove and Spring Valley Irrigation District; "Prevention and Correction of the Common Complaint Causes," handled by Bernard Schiller, sanitary engineer, Southern California Water Co.; and "Customer Approach and Closure of Cases," expounded by Roy E. Dodson, sanitary engineer of the San Diego Water Department.

The first paper of the afternoon was given by Robert T. Durbrow, Executive Secretary of the Irrigation Districts Assn. of California, on the subject "Problems Arising From Water Used From Irrigation Water Systems for Domestic Purposes." Although these districts were formed primarily to furnish water for agricultural purposes, many demands for domestic service are received from those who have no other source of supply, and this poses many problems of water purity. Hugh M. Wood, superintendent of the Ventura Water Department, presented a paper on the subject "Pre-

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paring for and Handling Problems of Water Shortage in Drought Periods." After a brief description of the development of the system, the author described drought conditions of last year and how they were met. At first, water shortage was publicized, irrigation water was rationed, and consumers were requested to conserve wherever possible, but as conditions became more critical, an emergency ordinance was adopted further reducing water usage. In general, most consumers cooperated, but there were some reports of violations, although no arrests or convictions were made. The author is of the opinion that development of storage for surface run-off would be the best solution for prevention of future water shortages in that area during drought periods.

The last paper of the afternoon was given by William J. Stephens, manager of the Personnel Division, East Bay Municipal Utility District, Oakland, on the subject of "Labor Relations." The afternoon session closed with a very brief discussion of pending legislation relative to water pollution control in California.

Entertainment was provided for the ladies during the day and the evening banquet which climaxed the conference was open to all. One hundred

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and seventy-two members and guests attended. After an excellent dinner and music presented by a marimba band, A. L. Trowbridge, engineer for the Kern County Land Co., gave a most interesting talk on the historical development of water in the Lower San Joaquin Valley. Entertainment was provided by "Dr. Mechado," a surprise speaker who, after a few introductory remarks, gave a story in rhyme of his impressions of the meeting. The conference was officially closed by Chairman Grayson with a reminder that Sacramento is the Fall Conference city and all are most cordially invited to attend.

H. C. Medbery
Secretary-Treasurer

New York: The annual Spring Meeting of the New York Section was held at the Hotel Mark Twain, Elmira, on Thursday and Friday, April 28 and 29, 1949. The meeting was attended by about 330 Association members, and general reports were that the program was an excellent one. It was particularly interesting, due to the fact that very able speakers were obtained.

Secretary Harry Jordan discussed the effect of the cold war on water works construction. John Murdoch Jr., Vice-President and Counsel of the Water Works Service Co. and President of the Pennsylvania Water Works Assn., presented an excellent paper of public interest on water rate increases.

The other papers of special interest were "Revision of Water Rates in the Light of Present-day Costs," by Maurice R. Scharf, consulting engineer of the Jamaica Water Supply Co., Jamaica, L.I., and "A Simplified Bookkeeping System for Small Water Works Plants," by George J. Natt, senior civil engineer, Water Power and Control Commission, Albany, N.Y. (June Journal, p. 479). Of particular note were both the Panel Discussion and Water Works Round Table Conference which were attended by and participated in by almost the entire membership present.

The usual business meeting was held and the Elmira College Women's Glee Club and the Cornell Savage Club entertained after the banquet.

R. K. Blanchard
Secretary-Treasurer

Pacific Northwest: An excellent program ranging from "Water Chlorination in Principle & Practice" by Harry Faber of New York to "Jack Frost and the Water System" by Fred Jones of Spokane was furnished by a very active committee under Arthur Musgrave at the twenty-second conference of the Pacific Northwest Section on May 12–14 at the Bellingham Hotel in Bellingham, Wash. Henry Donnelly, genial water su-

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perintendent, ably supported by Mayor Satterlee, Comptroller Loop, Auditor Moen, and Councilmen Rex Odell and Stanley Rogers, took care of the numerous details to be handled at any conference where 267 are in attendance. It was the largest meeting for the section to date.

Linn Enslow sat through all the sessions, actively participated in many discussions, helped the Trustees over several rough spots and gave a grand address on Friday night at the annual banquet. Jim Morrison, able Chairman, led the Trustees in several important discussions and gave an excellent account of himself at the Annual Banquet which Ed Thompson and Stanley Rogers had worked on for so many hours. Food was excellent, as well as the concert.

The Operators' Round Table was held at a Friday breakfast under John Gearhart. Sixty were supposed to be present; 110 were fed; and 20 turned away. That's the kind of show it was. Several able papers were presented on the 1948 Columbia flood damage to water systems, underground resources, short schools and registration, pre-stressed concrete reservoirs, and effects of use of water works income for general municipal purposes—a hot subject in the Northwest just now. Cy Everts presented an

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excellent committee report on Short Courses and Licensing, and a motion was made to place voluntary registration on a letter ballot.

No mention can be made of this convention without complimenting the hotels on their excellent service. In particular, John O'Rourke at the Bellingham did one of the outstanding jobs the writer has ever seen. He did everything he knew to help the boys enjoy the conference.

FRED MERRYFIELD
Secretary-Treasurer

Kansas Section: Despite a change in hotel managers, the joint meeting of the Kansas Section A.W.W.A. and the Kansas Sewage Works Assn. was held without difficulty at the Hotel Bisonte, Hutchinson, on April 21 and 22. H. H. Kansteiner, Section Chairman, presided at the opening session at which City Manager H. C. McClintock extended a welcome to all. Representing the national association was President-Elect A. P. Black, who was a stranger to no one by the end of the first day. By the end of the second day, no one was a stranger to Dr. Black. Everyone enjoyed his fellowship and timely thoughts immensely.

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D. G. McCammant, manager, and Ivan W. Jones, superintendent of the Hutchinson water system, described their unusual supply which depends upon wells encircling the city and pumping directly into the distribution system, rather than elevated storage. Orville G. Kuran, superintendent of maintenance at Kansas City, Kan., discussed "Emergency Maintenance," and the water pollution control program of the U.S.P.H.S. was discussed by Glen Hopkins, officer in charge of the Missouri River Basin for the service.

The afternoon session was opened by B. H. Van Blarcum, Manhattan water superintendent. The 1949 program of the state legislature as it affected public utilities was discussed by Major C. Hagar, who revealed that efforts to achieve a uniform retirement system for all public employees in the state seemed to assure passage of a measure by the 1951 legislature. "The Maintenance of Rapid Sand Filters" was discussed by C. E. Palmer, president of the Palmer Filter Equipment Co. of Erie, Pa.

Bob Millar, manager of the Wichita Water Co., discussed the "big brother" program of the section, which was developed to help any and all operators and cities over difficulties of every nature. During this exposition of the manner in which the program places information and help within the reach of every operator in the state, a surprise visit was made to the meeting by Governor Frank Carlson who, at Millar's insistence, gave a short talk in which he expressed his appreciation of the work the group was doing.

Panel discussions on water rate changes and main extension policies, participated in by Morris B. Willis, Iola city engineer; Lloyd B. Smith, Topeka commissioner of water; E. J. Allison, Salina city manager; and others, concluded the day's sessions. A buffet supper, entertainment and a business meeting made the evening an eventful one.

Water supply papers the next day, which was partially devoted to sewage interests, included "Geologic Methods of Prospecting for Ground Water" by O. S. Fent, consulting geologist of Salina (*see* p. 590, this issue); "Practical Experiences in Water Main Cleaning" by Robert Mounsey, assistant water superintendent of Lawrence; and "Tricks of the Trade," a collection of ingenious procedures developed and discussed by several persons. E. J. Trout explained how he had sand-blasted service lines to clean them; B. H. Radar discussed the sealing of a large hole underneath a reservoir dam; Charles F. McMannis demonstrated how compressed air could be used to grind the disc ball of a meter to fit more rapidly than hand methods; and H. E. McMillen described the use of a blank check bill form which simplified collection of accounts.

The "One Man Operator's Clinic," presided over by Bob Millar and George Pate, was devoted to the problems of small plant operators, several of whom discussed their experiences. The meeting was concluded by a banquet Friday evening at which Gene Conklin gave an address.

MAJOR C. HAGAR
Secretary-Treasurer

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19–21—Alabama-Mississippi Section in Jackson, Miss. Secretary: John L. Snow, Dist. Engr., Layne-Central Co., 601 First National Bank Bldg., Montgomery 4, Ala.

24–25—Virginia Section at Roanoke Hotel, Roanoke, Va. Secretary: W. H. Shewbridge, Asst. Engr., State Health Dept., 713 State Office Bldg., Richmond 19, Va.

26–28—California Section in Sacramento, Calif. Secretary: H. C. Medbery, Chief Water Purif. Engr., Water Dept., 425 Mason St., San Francisco 2, Calif.

31-Nov. 2—Kentucky-Tennessee Section at Lafayette and Phoenix Hotels, Lexington, Ky. Secretary: R. P. Farrell, Director, Div. of San. Eng., State Dept. of Public Health, 420—6th Ave., N., Nashville 3, Tenn.

November 2–4—Chesapeake Section at Wardman Park Hotel, Washington, D.C. Secretary: Carl J. Lauter, 5902 Dalecarlia Pl., N.W., Washington 16, D.C.

3–4—Ohio Section in Dayton, Ohio. Secretary: F. P. Fischer, Sales Engr., Wallace & Tiernan Co., Inc., 812 Perry Payne Bldg., Cleveland 13, Ohio.

7–9—North Carolina Section at Highland Pines Inn, Southern Pines, N.C. Secretary: E. C. Hubbard, Prin. San. Engr., State Board of Health, Raleigh, N.C.

11–13—Arizona Section at San Carlos Hotel, Yuma, Ariz. Secretary: Mrs. Helen Rotthaus, San Eng. Div., State Dept. of Health, Phoenix, Ariz.

14–16—Florida Section at Orange Court Hotel, Orlando, Fla. Secretary: A. E. Williamson Jr., P.O. Box 1431, Daytona Beach, Fla.

17–19—New Jersey Section at Madison Hotel, Atlantic City, N.J. Secretary: C. B. Tygert, Wallace & Tiernan Co., Inc., Box 178, Newark 1, N.J.

December 5–7—Southeastern Section at Gordon Hotel, Albany, Ga. Secretary: T. A. Kolb, San. Engr., State Board of Health, Wade Hampton Bldg., Columbia, S.C.

Index of Advertisers' Products

A complete Buyers' Guide to all water works products and services offered by A.W.W.A. Associate Members appears in the 1948 Membership Directory.